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Lieut.-General J. F. TENNANT, C.I.E., R.E., F.R.S., President, in the Chair.

John William Aldridge, 14 Hansford Street, Hackney Road, N.E.;
Thomas William Brownell, 26 Lincroft Street, Moss Side, Manchester;
George Cumes, F.R.G.S., Huntingdon House School, Teddington;
George Henderson, M.R.A.S., &c., Ovenden, Sevenoaks;
Frank Robbins, 154 Oakley Street, Chelsea, S.W.,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election, the names of the proposers from personal knowledge being appended:—

Robert Isaac Finnemore, J.P., F.R.Hist.Soc., Durban, Natal (proposed by P. Edward Dove);
William Friese-Greene, Photographer, 92 Piccadilly, W. (proposed by James Glaisher);
George Higgs, 467 West Derby Road, Liverpool (proposed by A. Cowper Ranyard);
Neville Holden, Solicitor, High Street, Lancaster (proposed by Squire T. S. Lecky);
Harold Jacoby, B.A., Columbia College Observatory, New York City, U.S.A. (proposed by David Gill).

Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1889, deduced from Photographs taken at Greenwich, at Dehra Dûn (India), and in Mauritius.

(*Communicated by the Astronomer Royal.*)

The results here given are in continuation of those printed in the *Monthly Notices*, vol. xlix. p. 380, and are deduced from the measurements of solar photographs taken at the Royal Observatory, Greenwich, at Dehra Dûn, India, and at the Royal Alfred Observatory, Mauritius.

Table I. gives the mean daily areas of umbræ, whole spots, and faculæ for each synodic rotation of the Sun in 1889, and Table II. the same particulars for the entire year. The areas are given in two forms: first, projected areas—that is, as seen and measured on the photographs, these being expressed in millionths of the Sun's apparent disc; and, next, areas as corrected for foreshortening, the areas in this case being expressed in millionths of the Sun's visible hemisphere. Table III. exhibits for each rotation in 1889 the mean daily area of whole spots, and the mean heliographic latitude of the spotted area, for spots north and for spots south of the equator, together with the mean heliographic latitude of the entire spotted area, and the mean distance from the equator of all spots; and Table IV. gives the same information for the year as a whole.

Table I.

No. of Rotation.	Date of Commencement of each Rotation.	No. of Days on which Photographs were taken.	Mean of Daily Areas. Projected. Umbræ.	Projected. Whole Spots.	Corrected for Foreshortening. Faculæ.	Corrected for Foreshortening. Umbræ.	Corrected for Foreshortening. Whole Spots.	Corrected for Foreshortening. Faculæ.
	d							
471	1888 Dec. 15·33	26	3·8	30·8	107	2·9	23·9	121
472	1889 Jan. 11·66	26	4·0	27·8	57·2	2·5	16·6	76·2
473	Feb. 8·00	27	5·9	33·6	75·1	3·4	20·0	79·6
474	Mar. 7·34	27	7·1	41·1	116	6·3	37·8	137
475	Apr. 3·64	27	4·7	32·7	38·9	2·7	18·7	46·9
476	Apr. 30·90	27	2·7	15·2	66·7	2·4	16·6	80·5
477	May 28·12	27	44·5	245	79·0	29·0	160	84·3
478	June 24·31	27	50·0	277	128	37·4	214	165
479	July 21·52	25	73·9	448	280	54·8	345	343
480	Aug. 17·74	27	22·4	122	131	17·9	101	175
481	Sept. 14·00	27	14·4	77·7	125	10·4	58·6	151
482	Oct. 11·28	28	0·2	2·6	72·1	0·1	1·9	93·0
483	Nov. 7·58	27	0·0	0·0	45·0	0·0	0·0	58·0
484	Dec. 4·89	27	14·1	81·9	166	12·7	76·3	214

TABLE II.

Year.	No. of Days on which Photographs were taken.	Mean of Daily Areas. Projected. Umbræ.	Projected. Whole Spots.	Projected. Faculæ.	Corrected for Foreshortening. Umbræ.	Corrected for Foreshortening. Whole Spots.	Corrected for Foreshortening. Faculæ.
1889	360	17·9	103	107	13·1	78·0	131

The rotations in Table I. and Table III. are numbered in continuation of Carrington's series (Observations of Solar Spots made at Redhill by R. C. Carrington, F.R.S.), No. 1 being the rotation commencing 1853 November 9. The assumed prime meridian is that which passed through the ascending node at mean noon on 1854 January 1, and the assumed period of the Sun's sidereal rotation is 25·38 days. The dates of the commencement of the rotations are given in Greenwich civil time, reckoning from mean midnight.

TABLE III.

No. of Rotation.	Date of Commencement of each Rotation.	No. of Days on which Photographs were taken.	Spots North of the Equator. Mean of Daily Areas.	Spots North of the Equator. Mean Heliographic Latitude.	Spots South of the Equator. Mean of Daily Areas.	Spots South of the Equator. Mean Heliographic Latitude.	Mean Heliographic Latitude of Entire Spotted Area.	Mean Distance from Equator of all Spots.
471	1888, Dec. 15·33	26	0·0	...	23·9	− 6°·63	− 6°·63	6°·63
472	1889, Jan. 11·66	26	2·8	+ 10·16	13·8	− 3·60	− 1·28	4·71
473	Feb. 8·00	27	0·0	...	20·0	− 7·18	− 7·18	7·18
474	Mar. 7·34	27	31·6	+ 6·08	6·2	− 7·16	+ 3·92	6·26
475	Apr. 3·64	27	17·6	+ 3·32	1·1	− 0·95	+ 3·06	3·18
476	30·90	27	0·0	...	16·6	− 2·03	− 2·03	2·03
477	May 28·12	27	0·0	...	160	− 5·94	− 5·94	5·94
478	June 24·31	27	0·0	...	214	− 6·64	− 6·64	6·64
479	July 21·52	25	7·6	+ 2·69	338	−13·78	−13·42	13·54
480	Aug. 17·74	27	0·0	...	101	−19·18	−19·18	19·18
481	Sept. 14·00	27	0·0	...	58·6	−21·08	−21·08	21·08
482	Oct. 11·28	28	1·6	+22·70	0·3	−25·20	+15·34	23·08
483	Nov. 7·58	27	0·0	...	0·0	...	...	...
484	Dec. 4·89	27	6·2	+24·27	70·0	−20·90	−17·21	21·17

TABLE IV.

Year.	No. of Days on which Photographs were taken.	Spots North of the Equator. Mean of Daily Areas.	Spots North of the Equator. Mean Heliographic Latitude.	Spots South of the Equator. Mean of Daily Areas.	Spots South of the Equator. Mean Heliographic Latitude.	Mean Heliographic Latitude of Entire Spotted Area.	Mean Distance from Equator of all Spots.
1889	360	5·0	+7°·26	73·0	−11°·90	−10°·68	11°·61

The foregoing tables would appear to show that the actual Sun-spot minimum fell during the past year. The mean daily

spotted area for the year as a whole was decidedly smaller than for 1888, whilst towards the end of the year there was a marked tendency for spots to form in high latitudes, so that the mean distance from the equator of all spots was considerably greater than in 1888. As Professor Spoerer has pointed out, the appearance of spots in high latitudes usually indicates the commencement of a new cycle. If the present be an example of this rule, then the new cycle may be taken as commencing in June 1889; for there were no instances of spots in latitudes higher than 10° until June 29, when a spot appeared in S. lat. 40°. At the same time the mean daily spotted area increased notably, for whilst it was only 22·5 for the first six rotations of 1889, as against 89 for 1888, it rose to 202 for the four following rotations. On the other hand, however, there have been but few spots since this outburst came to an end, and it may eventually prove to have been a mere accidental and temporary revival, and not the true commencement of the new cycle. The course of the solar activity during the next few months can hardly fail to decide the point.

Totality of the Eclipse of 1889 *December* 22. By David P. Todd.

(*Communicated by Dr. Huggins.*)

I located the eclipse expedition just north of Cape Ledo, a bold bluff on the West African coast, about 75 miles south of Saint Paul de Loanda.

Totality was completely lost in clouds, but a brief general description of the apparatus for the total eclipse, and of the novel method of operating it, will not be inappropriate.

Three essentials were recognised: (1) A great variety of apparatus; (2) large-scale pictures of the corona; (3) perfect clockwork. I saw no better way to meet these conditions than by constructing an equatoreal stand sufficiently capacious to accommodate all, or nearly all, the photographic apparatus. Accordingly, a split polar axis was built of 6-inch wrought-iron tubes, about 11 feet long, and placed 2 feet apart. The whole was mounted English fashion, on massive cast-iron supports, capped with brass bearings. This was built by Mr. Saegmueller, of Washington, and I was fortunate in obtaining from him the loan of a very perfect and powerful clockwork to drive it. This latter was in process of construction for the great equatoreal refractor of the Denver Observatory, and I found its centrifugal governor, a triple-twist flexible steel spindle, to perform with the highest accuracy. Also, the means provided by Mr. Saegmueller for adjusting the polar axis into parallelism with the earth's axis proved to be very neat; and the adjustment was readily made so close that, with an hour's run of the clock, the declination error on the plate did not exceed 20″.

On this axis was mounted all the photographic apparatus for the total eclipse, and a high-power directing telescope to verify the pointing of the whole.

This comprised the following apparatus:—

1. Professor Pickering's reversing-layer spectroscope, for photographing a spectrum trail for 15 seconds both before and after second and third contacts.

2. Five photographic telescopes, the first a Clark $\frac{150}{8}$ doublet, twelve exposures, two being through a Carbutt orthochromatising screen; the second a Dallmeyer $\frac{38}{6}$ rapid rectilinear lens, sixteen exposures; the third a Dallmeyer $\frac{24}{6}$ rapid rectilinear lens, four exposures; the fourth a Ross $\frac{44}{5}$ portrait lens, eighteen exposures; and the fifth a Gundlach $\frac{22}{3{\cdot}75}$ aplanatic orthoscope, with one specially-prepared plate for the extreme outer corona, and other circum-solar objects.

3. Two catoptric telescopes by Brashear, with twenty-five exposures for each, the first having the ratio $\frac{33}{8}$, with the central 3 inches of the mirror sacrificed to the plate-holder; while in the second, $\frac{72}{8}$, the entire aperture was made available by setting the plate-holder at one side of the tube, and tilting the mirror slightly, as in the Herschelian form of mounting.

4. Five dioptric telescopes, with objectives uncorrected for the actinic rays, the first a Clark-Merz $\frac{96}{6{\cdot}4}$ objective, twenty-five exposures, of which five were made with the full aperture, and five each with apertures of 5, 4, 3, and 2 inches; the second, a Schroeder $\frac{22}{6}$ triple objective, one hundred exposures; the third, a Clark $\frac{72}{5}$ telescope, with the Sun's image enlarged to 4·5 inches diameter, four exposures; the fourth, a Spencer $\frac{36}{4}$ objective, eighteen exposures, divided among apertures varying from 1 to 4 inches; the fifth, a Clark $\frac{49}{3{\cdot}5}$ objective, twenty-five exposures. This latter instrument was intended to provide pictures precisely comparable with those of the eclipse of 1889 January 1, taken by Mr. Barnard; and, accordingly, the aperture of the objective was capped down to 1·75 inches.

5. Two flint-glass spectroscopes, and one quartz spectroscope, provided by Harvard College Observatory.

6. Two duplex cameras for photographing the polarisation of the corona, prepared by Dr. Wright, of Yale University.

7. A duplex telescope of 75 inches focal length, for coronal photometry, prepared by Professor Bigelow, who also got all the spectroscopes into readiness for the eclipse.

The finder, or directing telescope, was a $7\frac{1}{4}$-inch Clark refractor, with a high-power eyepiece.

In all, the apparatus mounted upon the polar axis embraced two mirrors and twenty-three objectives.

The operation of it by hand, as ordinarily, would of course have been impossible. My experience during the eclipse in Japan two years previously had suggested the desirability of automatic operation of all eclipse apparatus; and, as a result of much experimentation with different electric and pneumatic devices, I finally ventured to adopt the pneumatic valve system covered by the letters patent of Mr. Merritt Gally.

By means of this unique system, which has been largely employed in the automatic playing of musical instruments, a very small current of exhaust air—say of one-tenth inch diameter—is made to control an exhaust current very many times greater in volume.

A system of forty-eight such valves offered no difficulties of construction whatever, and was built in ten days' time, under the immediate personal supervision of the inventor. The tubes leading from the valve ports were of half-inch diameter. The control currents were governed by a succession of one-tenth inch apertures punched in a strip of paper about 9 inches wide and 7 feet long. This I wound upon the barrel of an ordinary chronograph, so that it should unwind at a perfectly uniform rate when the chronograph was set going. As the paper left the barrel, it passed over the "tracker," and was rewound upon a take-up roller. The whole was mounted over an exhaust organ-bellows, strongly built, and with springs of triple tension. This combined apparatus made a perfect pneumatic commutator, having forty-eight air currents in perfect control. In order to set any current in motion, it was only necessary to puncture the control sheet at a point whose x was equal to the time, and whose y corresponded to the number of the air port in the "tracker."

From the commutator, half-inch lead pipes were run to the position of the different mechanical devices which were to come into action during totality. Here they were connected with small pneumatic bellows of the ordinary V-pattern.

Each bellows, then, was so connected by appropriate mechanical movements that its collapsing thrust should perform the various sorts of work required, whether the operation of an exposing shutter, the revolution of a Nicol, the variation of available aperture, or the shifting of a photographic plate.

In such a variety of apparatus, it was impossible that one form of mechanical movement should suffice for the whole. The

requirements of some of the instruments were best met by shutters, which the pneumatic bellows held open against the action of a spring during the full length of the exposure, while others required that alternate actions of the pneumatic should open and close the shutter, or exposing-slide. This was easy enough; but the problem of changing the sensitised plates for new exposures turned out to be much more difficult, especially where a large number of exposures was required.

Where the plates were small and the exposures few, a sliding plate-holder was found to work best; here it was only necessary to fasten a ratchet to the back of the plate-holder, and then attach a pawl to the vibrating side of the bellows. But some of the plates were of the size 17 inches by 20, and they could not be advantageously managed in this way. I finally hit upon the idea of attaching them to a revolving crate or barrel, set in motion on its axis by means of a small weight fastened to a cord wound upon a pulley or wheel at one end. An escapement-wheel was then placed on the barrel, with detents equal to the number of plates, and each detent so adjusted that when at rest its corresponding plate lay in the focal plane of the objective. A very small pneumatic then sufficed as a pallet, or as a trigger to set off the mechanical device on the conclusion of each exposure. This simple movement was found to be sure of action, easy of construction, and to require a minimum of time for shifting the plates.

Also, the capacities of other devices for shifting plates were tried. At the focus of one of the smaller instruments a plate was set in a small frame sliding laterally in a frame of twice its own dimension, and this latter again sliding longitudinally in a shallow box of twice the dimension of the outer frame. By means of three pneumatic bellows, appropriately set and fitted with ratchet movements, every part of the sensitive plate was brought to the centre of the focal plane, and the exposure duly made.

For the reflectors it was found best to employ an endless chain or belt of plates, double-hinged together by means of continuous flexible tapes.

In order to test the utmost capacity of the automatic apparatus, and at the same time to furnish a large series of pictures of the same corona with a given instrument, a quick-acting lens was rigged with a long plate-barrel, sliding automatically forth and back in a frame rigidly attached to the tube. The barrel had ten plate strips upon it, and the ratchet movements gave ten exposures for each strip. In this manner one hundred exposures, from a half-second to two seconds long, were readily obtained with a single instrument.

In order to avoid the construction of a camera-box for each telescope, I adopted the plan of mounting the polar axis near the middle of a house, one end of which had a removable roof, while the other formed a dark room. The spaces between all the

instruments in the axis were readily stopped, and a partition athwart the house was built up underneath the axis and down from the rafters of the house. It was then a simple matter to connect the partition with a wooden frame around the exterior of the polar axis, by means of heavy opaque cloth secured to the partition and the frame, with sufficient slack to allow the necessary motion of the polar axis and all the instruments mounted on it.

It may be further stated that substantially all this apparatus for the automatic movements was devised, constructed, and tested at sea, during the vogage of the U.S.S. "Pensacola" from New York to Saint Paul de Loanda.

Notwithstanding the evident impossibility of securing any pictures of the corona, as a thick cloud stood nearly stationary over the Sun at the time of totality, the pneumatic commutator was brought into operation, and the control chronograph set going 15 seconds before the predicted time of second contact. The duration of totality was 190 seconds, and over 300 exposures were made. The automatic movements of exposing-shutters and the other apparatus in the uncovered portion of the house were apparent; while, in the absence of pictures on the plates, the accurate registration of the movable plate-holders was rendered certain by the subsequent examination of marks so placed upon the slides as to disclose any failure of the mechanism to act.

Two other instruments of the expedition were ready for use during the total eclipse, and deserve mention here on account of their unusual proportions; one of them—the 40-foot direct photo-heliograph—which Professor Bigelow's ingenuity had provided with a sand-clock of extraordinary precision, and a sliding plate-holder for obtaining three photographs of the inner corona during totality; and the other—a 20 inch silver-on-glass mirror, of 75-foot focus—kindly lent to the expedition by Professor Langley, and which was so mounted as to throw an image of the corona into a huge camera-box set upon a cliff which lay fortunately just beneath the Sun at the time of totality. Here a 10-inch image of the Sun came to focus, beautifully defined, and 20×24 inch plates of the highest sensitiveness were prepared for exposure. But during totality both these unusual telescopes were also rendered inoperative by clouds.

The Apparent Projection of Stars upon the Bright Limb of the Moon at Occultation, and similar Phenomena. By Professor George Davidson, Ph.D., Sc.D., U.S. Coast and Geodetic Survey.

(*Communicated by the President.*)

In the *Observatory* for February 1890, upon p. 72, the Astronomer Royal is reported to have called attention to an occultation of a star by the Moon, among the occultations of 1889 at the Royal Observatory, that presented matter of "interest."

On September 16 Mr. Turner observed the occultation of *ζ Tauri* by the bright limb of the Moon, with the Lassell reflector of 24 inches, and Mr. Lewis with a refractor of three and three-fourths inches. Mr. Turner noted "no projection: disappeared instantaneously at bright limb." Mr. Lewis noted that "the star touched the limb of the Moon five seconds before the observation, and was slightly inside the limb. It appeared as a brilliant spot in the Moon, and disappeared suddenly at the time given above." On p. 69, Mr. Ranyard says that "in the case of *Jupiter* there are cases . . . . where one or two stars have apparently been seen through the limb of the planet. There are such a number of these observations that we cannot doubt that the planets have not a sharp limb, they seem to be surrounded by an atmosphere of great depth, or rather a gaseous envelope in which clouds or dusty matter float in irregular masses."

I have frequently seen this question brought forward with such unsatisfactory explanations that perhaps you will grant me the opportunity to present a few instances from my own experience, and my explanation of the phenomenon. My experience extends through forty-seven years as an observer, and to elevations reaching ten and eleven thousand feet above the sea.

In 1848 or 1849, during daylight, I observed the occultation of *α Scorpii* by the bright limb of the Moon, using a transit telescope with probably two and one-half inches aperture and low power. The red star touched the bright limb and I noted the time mentally, but as the star did not disappear I continued the watch for about two and one-half seconds longer, when the red star was unmistakably within the apparent limb. It disappeared instantaneously, and I noted that time also. I at once submitted the case to my chief, who said the time of disappearance was the true time of the occultation, but gave no explanation. I then submitted the observation to Superintendent Bache, who wrote to either Herschel or Airy on the subject. The reply was that he personally had never observed the phenomenon, but that there were some similar cases on record. However, he gave no explanation.

In the Survey of Admiralty Inlet and Puget Sound, about 1855, I again observed the occultation of *α Scorpii* by the bright

limb of the Moon at night, with phenomenon similar to that of 1848 or 1849. I probably used a three-inch Fraunhofer and moderate power.

My continuous geodetic and astronomical duties have long since led me to a solution of these and many somewhat similar appearances. *A spurious limb of the Moon is formed by the unsteadiness of our own atmosphere immediately surrounding the station of the observer.* This unsteadiness of the atmosphere throws the disc of the Moon into irregular vibrations of small amplitude and short duration; and from the same cause the star is not sharply defined as a steady point, but is seen fuzzy, flickering, and unsteady, with a bright nucleus.

The star approaches the actual limb of the Moon and both partake of the unsteadiness; but if the nucleus of the star be large and coloured, the impression of its image upon the eye is more intense than the image of the whitish, confused, spurious edge of the Moon, even when the former is inside the latter. The action of the eye is selective, and the effort is greater with the less favourable condition of a white star. There is no effort and no need of selection to receive an impression of the image of the Moon's limb, although it may be seen with high power.

The impression of the star's image is therefore continuous within the range of amplitude of the excursions of the disc of the Moon, but is instantly lost when the limit of range is reached and the actual limb of the Moon passes over the star.

With a large, coloured star the phenomenon is unmistakable; with a white star it may be somewhat in doubt; with a small white star it will very probably not be noted.

I have witnessed similar phenomena when the satellites of *Jupiter* have been occulted by the planet. In this case my fellow-observer with the smaller telescope, say of two and one-half or three inches, loses the satellite much sooner than I observe its disappearance in my 6·4-inch Clark equatoreal; and this will always occur with the larger objective and the higher power. When the atmosphere is steady and the limb of the planet sharply defined the above phenomenon is absent. When the atmosphere is remarkably steady the bright limb of the Moon is seen with all its serrations and irregularities, and then the star about to be occulted, whether large or small, coloured or white, apparently approaches it and instantly disappears at the point of contact. Under such conditions it never enters upon the limb of the Moon.

In geodetic work the phenomenon of false extension of the image of the heliotrope signal is the same as that for the false enlargement of the disc of the Sun, the Moon, *Jupiter*, or the image of a star. In the high Sierras of California, at 10,600 feet elevation, I have observed upon the minute images of heliotropes that did not measure one second of arc in diameter in the telescope, and were distant 120 to 160 miles to the north-west, where the wonderfully clear sky and the steady atmosphere after a

storm gave astonishing sharpness, steadiness, and nearness to all objects; and turning to the signals down to leeward the images of these heliotropes would range to thirty seconds of arc in diameter, and be remarkably diffuse, irregular, and unsteady. On a certain line of the triangulation in the coast range of mountains, where several mountain ridges and intervening valleys were crossed by the line of sight, and where the cold ocean air irruption, through the Karquines Strait, added tenfold confusion, the heliotrope image from Mount Diablo was like the waving flame from the stack of a smelting furnace, and sometimes exceeded sixty seconds of arc in diameter with its direction abnormal. When the air that the ray of light passed through became of uniform temperature the image was steady, small, and starlike, and its direction normal.

We meet with phenomena of similar character in observing upon all geodetic signals, especially in the less elevated regions; "poles" are only seen sharply and clearly defined when the atmosphere is supremely clear and still, and then at enormous distances. As a rule they are apparently broadened several times their normal width by the unsteadiness of the atmosphere.

It is this unsteadiness of the atmosphere, *and this alone*, which presents to the observer the phenomena of the "black drop," "ligament," &c., in the transits of *Venus* and *Mercury*; and the "Baily's beads," &c., in total solar eclipses.

When the atmosphere is fairly clear and remarkably steady, so that there is little or no irradiation from the disc of *Jupiter*, and necessarily no unsteadiness in the appearance of the satellites, I have been able to distinguish with the naked eye two satellites as one, when they were near each other. I have made public record of such occurrences; and at one station in the mountains all the members of my party saw the phenomenon. Under similar conditions of atmospheric serenity, but with the advantage of greater elevation, one or more of the professors from the United States Naval Observatory, then in the mountains of Colorado to observe the total solar eclipse of 1878, saw three satellites of *Jupiter* with the unassisted eye, the fourth being behind the planet. When these favourable conditions exist the occultation of a satellite by the planet is very satisfactorily observed.

In years of experience upon the Pacific Coast of the United States in observing lunar transits, I learned to expect wild results when a spurious bright limb of the Moon was observed, the resulting longitude being affected as if the diameter of the Moon were too great. At times, when the vibration or undulation of the disc of the Moon was not rapid, the sharp limb could be observed even with a faint spurious outline beyond it. Within the last two months my party has had a case of spurious disc from excessive diffusiveness, with a predicted error in the resulting longitude that was verified.

In my observations of the last transit of *Venus*, at 5,691 feet above the sea and 1,600 feet above the arid Jornada del Muerte,

there were at one time occasional shiverings of the discs of the Sun and planet from slight tremulousness of the atmosphere, but the eye was not confused, as would have been the case if the discs had been ill-defined and unsteady by excessive vibration. In the first case the eye could and did select its opportunity for measurement. At other stations for the same transit the atmospheric disturbance distorted the appearance of the fine crescent of coronal light apparently surrounding part of the disc of *Venus* when the planet was partially off the Sun's limb; but at Cerro Roblero the steadiness of the atmosphere at the time of the last exhibition of this phase permitted us to see the long, thin, white crescent, as fine and sharp and regular as if cut by a graver, die away in excessive minuteness.

In conclusion, I may mention that I have been fortunate in my observations of the transits of *Venus* and of *Mercury* never to have had the exhibition of "ligament" or "black drop"; and in solar eclipses to have never seen "Baily's beads," &c. In my experience the occurrence of supreme steadiness of the atmosphere is very rare indeed, but has happened oftener at great elevations of mountain peaks, and the narrow crest-line of a mountain-range during the winter season of this coast.

The Jovian Evection. By E. Nevill.

In the year 1876, whilst discussing the observations of the Moon made at Greenwich and Washington during the years 1862–74, Professor Newcomb discovered a new inequality in the motion of the Moon in longitude.

This inequality was subsequently shown to arise from the disturbing action of the planet *Jupiter*, and to be the term in the perturbations produced by that planet which corresponds to the well-known *evection* due to the disturbing action of the Sun. Hence the name—the *Jovian Evection.*

In the *Memoirs* (vol. xxix., 1861) Sir G. Airy has given the results obtained by him from a discussion of the Greenwich lunar observations during the period 1750–1851, and among other results he has deduced the corrections to the adopted theory having for argument the sine and the cosine of the Moon's mean anomaly. He gives the value deduced for the coefficient of these terms for twenty-one consecutive periods of about nine years each. These coefficients are tabulated on pp. 12 and 14, under the heads—values of S and of T respectively.

From a discussion of these values Sir G. Airy deduces the existence of apparent inequalities in the longitude of the Moon of the form—

$$+0''{\cdot}47 \sin(\alpha+B)$$
$$-0''{\cdot}17 \cos(\alpha+B)$$
$$-1''{\cdot}12 \sin(\alpha-B)$$
$$+0''{\cdot}37 \cos(\alpha-B)$$

where α denotes the Moon's mean anomaly, and B denotes the mean longitude of the ascending node of the orbit of the Moon.

The disturbing action of neither the Sun nor planets can give rise to inequalities of this form in the expression for the longitude of the Moon, and Sir G. Airy appears to have been unable to account for their existence, although convinced that they were real. Yet even at that period it might have been seen that terms of this form must be introduced through the effect of the ellipticity of the Earth, for it was known that through this cause a term was introduced into the expression for the Moon's longitude having for its argument the longitude of the Moon's node as measured from the true equinox. Under the form—

$$+6''{\cdot}6 \sin (u-y), \quad \text{or} \quad 6''{\cdot}6 \sin \mathrm{B},$$

this term had been introduced into the tables on which Sir G. Airy had based his reductions; but as this term does not involve the mean longitude of the Moon in its argument it must have associated with it two companion inequalities with the arguments

$$(\alpha+\mathrm{B})$$
$$(\alpha-\mathrm{B})$$

with small coefficients of the same order as those found from observation by Sir G. Airy.

As the *Jovian Evection* differs in period very slightly from the *mean anomaly*, it must give rise to an apparent inequality in the value found from observation for the terms with the argument *sine mean anomaly* and *cosine mean anomaly*. Hence, from a discussion of the variations in the values of these coefficients, as given by Sir G. Airy under the headings S and T (pp. 12 and 14, *Memoirs*, vol. xxix., 1861), it should be possible to derive the value of the *Jovian Evection*.

Let

A denote the mean longitude of the perigee of the lunar orbit,

l_{iv} denote the mean longitude of the planet *Jupiter*,

then the argument of the *Jovian Evection* may be written in the form

$$2\,\theta_{\mathrm{iv}}-\alpha=\alpha-2(l_{\mathrm{iv}}-\mathrm{A}),$$

where the mean motion of

$$2(l_{\mathrm{iv}}-\mathrm{A})$$

differs from the mean motion of the Moon's ascending node by only the very small quantity

$$\kappa=-1^{\circ}{\cdot}32\ (\mathrm{T}-1832{\cdot}0).$$

Hence the argument of the *Jovian Evection* can be written as

$$2\theta_{\mathrm{iv}}-\alpha=\alpha-(\mathrm{B}+\kappa).$$

It remains to deduce the exact value of the *Jovian Evection* and associated inequalities from a discussion of the values for the coefficients S and T of the terms with the argument sin α

and cos α, derived by Sir G. Airy from the Greenwich lunar observations made between 1750 and 1851.

Suppose the complete expression for the Moon's true longitude to contain the terms

$$\delta v = +A_s \sin \alpha + \overset{+}{B}_s \sin(\alpha+B) + \overset{-}{B}_s \sin(\alpha-B) + K_s \sin(\alpha-[B+\kappa])$$
$$+ A_c \cos \alpha + \overset{+}{B}_c \cos(\alpha+B) + \overset{-}{B}_c \cos(\alpha-B) + K_c \cos(\alpha-[B+\kappa])$$

then

$$S = A_s + \{(\overset{-}{B}_s + \overset{+}{B}_s) + K_s \cos\kappa + K_c \sin\kappa\}\cos B + \{(\overset{-}{B}_c - \overset{+}{B}_c) - K_s \sin\kappa + K_c \cos\kappa\}\sin B$$

and

$$T = A_c - \{(\overset{-}{B}_s - \overset{+}{B}_s) + K_s \cos\kappa + K_c \sin\kappa\}\sin B + \{(\overset{-}{B}_c + \overset{+}{B}_c) - K_s \sin\kappa + K_c \cos\kappa\}\cos B.$$

For convenience, the mean value of S or $(-0{\cdot}364)$ has been subtracted from each separate value for S, and after applying to T Sir G. Airy's correction for the motion of anomaly

$$= -0{\cdot}496 - 0{\cdot}162 \times \text{number of group from } 1801{\cdot}5,$$

they have been reduced to the same unit as those of S or to a T.

There are thus obtained the following system of equations of condition :—

A_s	$\overset{+}{B}_s$	$\overset{-}{B}_s$	$\overset{+}{B}_c$	$\overset{-}{B}_c$	K_s	K_c	S
+1	−1	−1	0	0	+ ·19	− ·98	= +·082
+1	0	0	−1	+1	−1·00	− ·09	= +·106
+1	+1	+1	0	0	+ ·02	+1·00	= −·005
+1	0	0	+1	−1	+ ·99	·12	= −·120
+1	−1	−1	0	0	− ·20	− ·97	= +·013
+1	0	0	−1	+1	− ·95	+ ·33	= +·169
+1	+1	+1	0	0	+ ·42	+ ·91	= +·063
+1	0	0	+1	−1	+ ·85	− ·53	= −·027
+1	−1	−1	0	0	− ·62	− ·79	= +·113
+1	0	0	−1	+1	− ·72	+ ·70	= +·125
+1	+1	+1	0	0	+ ·77	+ ·64	= −·139
+1	0	0	+1	−1	+ ·56	− ·83	= −·150
+1	−1	−1	0	0	− ·89	− ·45	= −·067
+1	0	0	−1	+1	− ·36	+ ·93	= −·011
+1	+1	+1	0	0	+ ·97	+ ·26	= −·049
+1	0	0	+1	−1	+ ·16	− ·99	= +·062
+1	−1	−1	0	0	−1·00	− ·05	= +·091
+1	0	0	−1	+1	+ ·05	+1·00	= −·123
+1	+1	+1	0	0	+ ·99	− ·16	= −·203
+1	0	0	+1	−1	− ·26	− ·97	= +·011
+1	−1	−1	0	0	− ·93	+ ·36	= +·071

A_c	$\overset{+}{B}_s$	$\overset{-}{B}_s$	$\overset{+}{B}_c$	$\overset{-}{B}_c$	K_s	K_c	aT
+1	0	0	−1	−1	+ ·98	+ ·19	= −·152
+1	+1	−1	0	0	+ ·09	−1·00	= +·000
+1	0	0	+1	+1	−1·00	+ ·02	= +·035
+1	−1	+1	0	0	+ ·12	+ ·99	= −·100
+1	0	0	−1	−1	+ ·97	− ·23	= +·037
+1	+1	−1	0	0	− ·33	− ·95	= +·170
+1	0	0	+1	+1	− ·91	+ ·42	= +·028
+1	−1	+1	0	0	+ ·53	+ ·85	= −·047
+1	0	0	−1	−1	+ ·79	− ·62	= −·006
+1	+1	−1	0	0	− ·70	− ·72	= +·178
+1	0	0	+1	+1	− ·64	+ ·77	= +·012
+1	−1	+1	0	0	+ ·83	+ ·56	= −·192
+1	0	0	−1	−1	+ ·45	− ·89	= −·000
+1	+1	−1	0	0	− ·93	− ·36	= +·256
+1	0	0	+1	+1	− ·26	+ ·97	= +·050
+1	−1	+1	0	0	+ ·99	+ ·16	= −·158
+1	0	0	−1	−1	+ ·05	−1·00	= −·109
+1	+1	−1	0	0	−1·00	+ ·05	= +·097
+1	0	0	+1	+1	+ ·16	+ ·99	= −·030
+1	−1	+1	0	0	+ ·97	− ·26	= −·197
+1	0	0	−1	−1	− ·36	− ·93	= +·124

These yield the following set of normal equations :—

A_s	A_c	$\overset{+}{B}_s$	$\overset{+}{B}_c$	$\overset{-}{B}_s$	$\overset{-}{B}_c$	K_s	K_c	
+21·00	+ ·00	− 1·00	+ ·00	− 1·00	+ ·00	− ·98	− ·80	= + ·012
+ ·00	+21·00	+ ·00	− 1·00	+ ·00	− 1·00	+ ·80	− ·98	= − ·004
− 1·00	+ ·00	+21·00	+ ·00	+ 1·00	+ ·00	+ ·34	+ ·26	= + ·759
+ ·00	− 1·00	+ ·00	+21·00	+ ·00	+ 1·00	− ·26	+ ·34	= − ·289
− 1·00	+ ·00	+ 1·00	+ ·00	+21·00	+ ·00	+12·96	+10·80	= −2·031
+ ·00	− 1·00	+ ·00	+ 1·00	+ ·00	+21·00	−10·80	+12·96	= + ·691
− ·98	+ ·80	+ ·34	− ·26	+12·96	−10·80	+21·00	+ ·00	= −2·378
− ·80	− ·98	+ ·26	+ ·34	+10·80	+12·96	+ ·00	+21·00	= − ·681

On solution these yield the following set of values for the eight unknowns :—

$A_s = -·0041$	$K_s = -·1018$	$\overset{+}{B}_s = +·0393$	$\overset{-}{B}_s = -·0320$
$A_c = +·0017$	$K_c = -·0078$	$\overset{+}{B}_c = -·0141$	$\overset{-}{B}_c = -·0138$

To reduce these to seconds of arc multiply the first pair by $7''$, and the others by $7'' \times \frac{\pi}{2}$. They then become

$$A_s = -''\cdot 029 \qquad K_s = -1''\cdot 120 \qquad \overset{+}{B}_s = +''\cdot 432 \qquad \overset{-}{B}_s = -''\cdot 352$$

$$A_c = +\cdot 012 \qquad K_c = -\cdot 086 \qquad \overset{+}{B}_c = -\cdot 155 \qquad \overset{-}{B}_c = -\cdot 152$$

Hence the value of the *Jovian Evection* derived from Sir G. Airy's reduction of the Greenwich lunar observations for the period 1750–1851 is

$$\textit{Jovian Evection} = -1''\cdot 120 \sin(2\theta_{iv} - \alpha) - 0''\cdot 086 \cos(2\theta_{iv} - \alpha).$$

The supplementary terms are

$$= -0''\cdot 352 \sin(\alpha - B) - 0''\cdot 152 \cos(\alpha - B)$$
$$+ 0\cdot 432 \sin(\alpha + B) - 0\cdot 155 \cos(\alpha + B).$$

The values found by Sir G. Airy were

$$-1''\cdot 12 \sin(\alpha - B) + 0''\cdot 37 \cos(\alpha - B)$$
$$+ 0\cdot 47 \sin(\alpha + B) - 0\cdot 17 \cos(\alpha + B).$$

Hence the first pair are reduced to about a third of the value found by Sir G. Airy and the sign of the cosine term is changed, whilst the second pair remain practically unaltered.

Put

$$a = 2(l_{iv} - A),$$

then as far as the same set of terms is concerned

$$\delta v = + \{K_s + A_s \cos a - A_c \sin a + \overset{-}{B}_s \cos\kappa - \overset{-}{B}_c \sin\kappa\} \sin(2\theta_{iv} - \alpha)$$
$$+ \{\overset{+}{B}_s \cos\kappa + \overset{+}{B}_c \sin\kappa\} \sin(2\theta_{iv} - \alpha + 2a)$$
$$+ \{K_c + A_s \sin a + A_c \cos a + \overset{-}{B}_s \sin\kappa + \overset{-}{B}_c \cos\kappa\} \cos(2\theta_{iv} - \alpha)$$
$$- \{\overset{+}{B}_s \sin\kappa - \overset{+}{B}_c \cos\kappa\} \cos(2\theta_{iv} - \alpha + 2a).$$

Hence these terms give rise to inequalities in the apparent value of the coefficient of the *Jovian Evection* of the form

$$\delta K_s = A_s \cos a - A_c \sin a + \overset{-}{B}_s \cos\kappa - \overset{-}{B}_c \sin\kappa$$

$$\delta K_c = A_s \sin a + A_c \cos a + \overset{-}{B}_s \sin\kappa + \overset{-}{B}_c \cos\kappa.$$

In determining from observation the apparent value of the coefficient of the *Jovian Evection* care is taken to eliminate the terms depending on the argument a, so that there only remain the terms depending on the argument κ, or

$$\delta K_s = \overset{-}{B}_s \cos\kappa - \overset{-}{B}_c \sin\kappa \qquad \delta K_c = \overset{-}{B}_s \sin\kappa - \overset{-}{B}_c \cos\kappa.$$

It remains to ascertain how far this inequality affects the values for the *Jovian Evection* which have been deduced from

the observations of late years. There are four such values, based on the comparison of Hansen's Tables with the observations for the periods :—

I.	1847–58	Mean year 1853·0
II.	1862–74	1868·5
III.	1862–77	1870·0
IV.	1878–88	1883·5

Hence from the value of κ

I.	$\delta K_s = +\cdot86\,\bar{B}_s + \cdot52\bar{B}_c$	$\delta K_c = -\cdot52\,\bar{B}_s + \cdot86\,\bar{B}_c$
II.	$= +\cdot65 \quad +\cdot76$	$= -\cdot76 \quad +\cdot65$
III.	$= +\cdot62 \quad +\cdot79$	$= -\cdot79 \quad +\cdot62$
IV.	$= +\cdot33 \quad +\cdot95$	$= -\cdot95 \quad +\cdot33$

By employing the values of $\bar{B}_s . \bar{B}_c$, given by the preceding discussion of the Greenwich observations for the period 1750–1851, or

$$\bar{B}_s = -0''\cdot35$$

$$\bar{B}_c = -0\cdot14,$$

there results the correction

I.	$\delta K_s = -0''\cdot48$	$\delta K_c = +0''\cdot06$
II.	$= -0\cdot35$	$= +0\cdot17$
III.	$= -0\cdot33$	$= +0\cdot20$
IV.	$= -0\cdot23$	$= +0\cdot29$

Hence the value of these coefficients, as deduced from the observations of these periods, will appear too large by the above quantities.

Before proceeding it is necessary to know the theoretical value for the coefficient of the *Jovian Evection.*

From a provisional investigation (*Monthly Notices*, April 1877, p. 358) the theoretical value of the main portion of this coefficient was determined to be

$$K_s = -1''\cdot163.$$

Besides the principal term there exist some secondary small ones, whose sum was determined by a provisional investigation to be (*Memoirs*, vol. xlviii. p. 403)

$$\delta K_s = -0''\cdot105 \qquad \delta K_c = +0''\cdot182.$$

A subsequent more extended investigation shows these values to be somewhat too great, and the true theoretical value of the *Jovian Evection* may be said to be

$$K_s = -1''\cdot186 \qquad K_c = +0''\cdot106.$$

Professor G. W. Hill, in his computation of the theoretical value of this term, makes the value to be

$$K_s = -0''.903 \qquad K_c = +0''.000.$$

("On certain Lunar Inequalities due to the Action of Jupiter," *Astronomical Papers, American Nautical Almanac*, vol. iii., part iv., p. 390, 1886.) But it has been shown that there is reason to believe that the method employed by Professor Hill is not complete, and yields only a portion of the complete value of the coefficient of this term (*Monthly Notices*, June 1886, p. 403).

By employing this value of the theoretical coefficient of the *Jovian Evection* there are obtained the following for the apparent value of the *Jovian Evection* at the different specified epochs:—

I. 1853·0	$K_s = -1''.67$	$K_c = +0''.17$
II. 1868·5	$= -1''.54$	$= +0''.28$
III. 1870·0	$= -1''.52$	$= +0''.31$
IV. 1883·5	$= -1''.42$	$= +0''.40$

From a discusion of the observations made at Greenwich during the twelve years 1847–58 Professor Newcomb found for the epoch 1853 the value

$$\text{I. } K_s = -1''.66.$$

From a more elaborate discussion of the thirteen years' observations made at Washington and Greenwich during the period 1862–74, Professor Newcomb found for the epoch 1868·5 the value

$$\text{II. } K_s = -1''.53$$

(*Monthly Notices*, June 1876, p. 360).

From a discussion of the observations made at Greenwich during the sixteen years 1862–77 it was shown that for the epoch 1870 the value of the term was

$$K_s = -1''.41 \qquad K_c = +0''.15.$$

But in this investigation ("On the Corrections required by Hansen's Tables de la Lune," *Memoirs*, vol. xlviii., 1885, p. 402) it was supposed that the motion of the lunar perigee adopted in the tables was sensibly correct. A more extensive comparison of Hansen's Tables with observation has shown that this is not the case, and that it is necessary to apply a correction to the tabular motion of the lunar perigee. This has rendered it necessary to revise the investigation, and on revision there is obtained for the epoch 1870 the values

$$\text{III. } K_s = -1''.51 \qquad K_c = +0''.28.$$

Last year, on the completion of the discussion of the results obtained by comparing Hansen's Tables with the Greenwich observations for the eleven years 1878–88, it was ascertained that the observations for this period yielded for the epoch 1883·5 the values

$$\text{IV. } K_s = -1''\cdot43 \qquad K_c = +0''\cdot47.$$

A comparison of these results with those calculated above show how closely they agree :—

Epoch.	Observed.	Calculated.	Observed.	Calculated.
I. 1853·0	$K_s = -1''\cdot66$	$-1''\cdot67$	$K_c =$ ...	$+0''\cdot17$
II. 1868·5	$= -1\cdot55$	$-1\cdot54$	= ...	$+0\cdot28$
III. 1870·0	$= -1\cdot51$	$-1\cdot52$	$= +0\cdot28$	$+0\cdot31$
IV. 1883·5	$= -1\cdot43$	$-1\cdot42$	$= +0\cdot47$	$+0\cdot40$

No comparison between observation and calculation could agree more closely, or appear more satisfactory. Yet this very agreement is a striking illustration of the difficulties inherent in the perfection of the theory of the Moon, and affords an example of the unexpected difficulties which have done so much to retard my work on the Theory of the Terms of Long Period in the motion of the Moon, and especially in that part where the theory has to be compared with observation.

For, complete and satisfactory as it looks, this agreement is entirely fortuitous, and means exactly nothing. This is for two reasons, both such as might easily escape attention.

First, because the small differences between the theory embodied in the lunar tables employed by Sir G. Airy and that forming the basis of Hansen's Tables rises into importance in the case of this particular inequality—the *Jovian Evection.*

Second, because, quite unexpectedly, further investigation shows that the values deduced by Professor Newcomb for the coefficient of his empirical term differ materially from the true value of the coefficient of the *Jovian Evection* deduced from the same data, though the arguments of the two are so nearly the same.

Considering the first of these reasons, it can be shown that when the observations are referred to Airy's tables there will appear to exist inequalities of the form

$$+0''\cdot52 \sin(\alpha+B) + 0''\cdot04 \cos(\alpha+B)$$
$$-0\cdot52 \sin(\alpha-B) + 0\cdot04 \cos(\alpha-B),$$

which will not appear when the same observations are referred to Hansen's Tables, though apparently both tables are alike in respect to terms of this kind.

For the effect of the ellipticity of the Earth on the motion of the Moon in longitude is taken into account by Sir G. Airy by introducing a term as an inequality in the true longitude,

whereas Professor Hansen introduces this term as an inequality of the mean longitude; but when introduced as by Sir G. Airy the principal term requires to be accompanied by a pair of smaller terms of the form

$$+0''.52 \sin(\alpha+B)$$
$$-0''.52 \sin(\alpha-B),$$

whereas no such terms are required when the principal term is introduced as by Professor Hansen. As Sir G. Airy has omitted these auxiliary terms from the tables used by him they will appear in the discussion of the observations in the form of small apparent inequalities in the coefficients of the terms depending on the argument mean anomaly; but no such inequalities will exist when the observations are referred to Hansen's Tables.

Again, in the lunar tables employed by Sir G. Airy there are no terms to take account of the effect of the motion of the plane of the ecliptic; in consequence, when the observations are referred to these tables, there will appear small inequalities in the coefficients of the terms depending on the mean anomaly of the form

$$+0''.04 \cos(\alpha+B)$$
$$+0''.04 \cos(\alpha-B).$$

But no such inequalities will appear when the same observations are referred to Hansen's Tables, because, though they contain no distinct terms to take into account the effect of the motion of the ecliptic, yet this is done by slightly modifying the constant portion of the argument depending on the longitude of the node.

It follows, therefore, that these terms—due to imperfections in Airy's tables—must be subtracted from those found in the previous investigation before the results can be used to correct the values of the coefficient of the *Jovian Evection* founded on observations referred to Hansen's Tables. Hence the value of the coefficients which must be employed are—

$$\overset{+}{B}_s = (+0''.43) - (+0''.52) = -0''.09 \pm 0''.12$$
$$\overset{+}{B}_c = (-0''.15) - (+0''.04) = -0''.19 \pm 0''.12$$
$$\overset{-}{B}_s = (-0''.35) - (-0''.52) = +0''.17 \pm 0''.19$$
$$\overset{-}{B}_c = (-0''.15) - (+0''.04) = -0''.19 \pm 0''.19$$

Considering the uncertainty which attaches to the values deduced from observation, it is doubtful if any of these quantities is entitled to be considered real.

The values obtained by Professor Newcomb are

From the Observations of 1847–58.	From the Observations of 1862–74.
$-1''.66$	$-1''.55$

These are not really the values of the coefficient of the *Jovian Evection*, but of an empirical term differing slightly in epoch and period; and though the difference is so small that it might be deemed immaterial, yet a recalculation from the same data, only using the true argument, showed that this was not the case. For the results obtained are

From the Observations of 1847–58.	From the Observations of 1862–74.
$K_s = -1''.38$	$K_s = -1''.54$
$K_c = -0.16$	$K_c = +0.29$

Thus, though the results derived from the observations of 1862–74 agree with those deduced by Professor Newcomb, yet this is not true of those obtained from the observation of the earlier period 1847–58. The apparent coefficient of the *Jovian Evection* is more than a quarter of a second smaller. A possible explanation of this discrepancy soon presented itself.

The comparison which has been made between Hansen's Tables and observation (*Memoirs*, 1885) shows that the tables require a correction of the form

$$B' \sin(\theta + \mu) + B'' \cos(\theta + \mu),$$

and from this there arises an eighteen-year inequality in the apparent value of the coefficient of the *Jovian Evection*. As the period covered by each of these series of observations falls far short of eighteen years, it follows that the values for the coefficient of the *Jovian Evection* deduced from them will require correction for the effect of this inequality. The true values will be—

From the Observations of 1847–58.	From the Observations of 1862–74.
$K_s = -1''.38 + .48\,B' - .15\,B''$	$K_s = -1''.54 + .30\,B' + .16\,B''$
$K_c = -0.16 + .15\,B' + .48\,B''$	$K_c = +0.29 - .16\,B' + .30\,B''$

A discussion of the observations for the sixteen years 1862–1877 yields for the approximate values of these coefficients

$$B' = -0''.59$$
$$B'' = +0.38$$

It is likely, taking into consideration the probable origin of this inequality, that these coefficients in turn are affected by small inequalities of long period, and that these values are only true of the epoch for which they are determined; but for the present purpose they must be applied as they stand, excepting that, as Professor Newcomb has already applied to the observation for 1862–74 the correction

$$-0''.13 \sin(\theta + \mu),$$

for these observations, the value given above for B′ must be diminished by this amount.

This correction reduces the preceding expressions to

From the Observations of 1847–58.	From the Observations of 1862–74.
$K_s = -1''.71$	$K_s = -1''.62$
$K_c = -0.07$	$K_c = +0.48$

Hence the real values of the *Jovian Evection* indicated by observation are somewhat greater than calculated by Professor Newcomb as the value of his empirical term.

The preceding investigation shows clearly that the observations indicate a value for the apparent coefficient of the *Jovian Evection* which is much greater than that resulting from theory, and render it certain that with it there is associated another inequality of some magnitude and of very similar period. It also establishes that, had Sir G. Airy been more strict in examining the results obtained by him from the reduction of the Greenwich lunar observations for the years 1750–1851, he might have discovered the existence of the *Jovian Evection* fully thirty years ago.

Both of these conclusions suggest inquiries of some interest in the theory of the motion of the Moon.

1890 *February* 20.

On the Orbit of δ Cygni. By J. E. Gore.

The following elements of *δ Cygni* I computed some three years ago, but as they give the distance at the epoch of Sir W. Herschel's measure in 1783 somewhat too large, I did not publish them. As, however, they represent all the measures of position-angle fairly well, I now give them for what they are worth.

Provisional Elements of δ Cygni.

$P = 376.659$ years	$\Omega = 98° 40'$
$T = 1914.16$	$\lambda = 175° 7'$
$e = 0.327$	$a = 2''.39$
$i = 41° 26'$	$\mu = -0°.9557$

The following is a comparison between the recorded measures and the positions computed from the above elements. The observed position-angles have been corrected for the effect of precession to 1880·0 :—

Epoch.	Observer.	θ_o	θ_c	$\theta_o - \theta_c$	ρ_o	ρ_c	$\rho_o - \rho_c$
1783·72	Sir W. Herschel	70°.98	70°.32	+0°.66	″ ...	″ 2·72	″ ...
1826·55	Struve	40·2	40·75	−0·55	1·91	2·04	−0·13
1828·80	„	36·5	38·7	−2·2	1·91	2·00	−0·09
1831·73	„	36·4	35·8	+0·6	1·57	1·95	−0·38

Epoch.	Observer.	θ_o	θ_c	$\theta_o - \theta_c$	ρ_o	ρ_c	$\rho_o - \rho_c$
		°	°	°	"	"	"
1832·72	Sir J. Herschel & South	32·3	34·7	−2·4	1·5	1·93	−0·43
1833·81	Struve	35·9	33·7	+2·2	1·70	1·91	−0·21
1835·66	„	34·3	31·7	+2·6	1·68	1·89	−0·21
1836·52	„	31·6	30·75	+0·85	1·80	1·87	−0·07
1837·27	Mädler	31·0	29·9	+1·1	1·61	1·87	−0·21
1837·78	Smyth	30·6	29·3	+1·3	1·5	1·87	−0·37
1839·66	Dawes	27·1	27·2	−0·1	1·5	1·83	−0·33
1840·67	„	24·8	26·1	−1·3	...	1·81	...
1841·50	Mädler	26·3	25·1	+1·2	...	1·80	...
1841·89	Dawes	23·4	24·7	−1·3	1·66	1·80	−0·14
1841·94	Kaiser	25·4	24·6	+0·8	1·72	1·79	−0·07
1842·56	Smyth	25·3	23·7	+1·6	1·8	1·78	+0·02
1842·77	Mädler	21·3	23·5	−2·2	1·46	1·78	−0·32
1843·12	Kaiser	25·5	23·1	+2·4	1·71	1·78	−0·07
1843·45	Mädler	22·4	22·7	−0·3	(1·28)	1·77	(−0·49)
1844·36	„	23·7	21·6	+2·1	1·47	1·75	−0·28
1844·78	O. Struve	19·4	21·1	−1·7	1·68	1·75	−0·07
1845·65	Mädler	21·7	20·0	+1·7	1·32	1·74	−0·42
1846·35	„	20·0	19·1	+0·9	1·33	1·74	−0·41
1847·18	„	18·8	18·0	+0·8	...	1·73	...
1847·39	Dawes	16·5	17·7	−1·2	...	1·73	...
1848·75	„	14·3	15·9	−1·6	1·76	1·72	+0·04
1851·51	„	11·3	12·2	−0·9	1·65	1·66	−0·01
1851·68	Fletcher	10·1	12·0	−1·9	1·75	1·66	+0·09
1852·44	Mädler	13·6	10·9	+2·7	(1·19)	1·64	(−0·45)
1852·69	Smyth	14·5	10·5	+4·0	1·5	1·64	−0·14
1852·70	O. Struve	8·1	10·5	−2·4	1·51	1·64	−0·13
1852·74	Dawes	10·5	10·5	0·0	1·68	1·64	+0·04
1853·73	„	7·1	9·1	−2·0	1·76	1·64	+0·12
1854·56	„	4·1	7·9	−3·8	1·68	1·64	+0·04
1854·76	Morton	(0·8)	7·6	(−6·8)	(1·11)	1·64	(−0·53)
1855·74	„	(0·2)	6·2	(−6·0)	(1·27)	1·62	(−0·35)
1856·84	Secchi	3·0	4·6	−1·6	1·41	1·61	−0·20
1858·71	O. Struve	3·1	1·8	+1·3	1·65	1·60	+0·05
1859·58	Dawes	357·6	0·5	−2·9	1·67	1·59	+0·08
1862·75	Dembowski	355·3	355·6	−0·3	...	1·57	...
1863·61	„	355·4	354·2	+1·2	1·58	1·57	+0·01
1863·74	O. Struve	353·7	354·0	−0·3	1·60	1·57	+0·03

Epoch.	Observer.	θ_o	θ_c	$\theta_o-\theta_c$	ρ_o	ρ_c	$\rho_o-\rho_c$
1864·72	Dembowski	351°·2	352°·56	−1°·36	1″·68	1″·56	+0″·12
1864·74	Engelmann	354·3	352·53	+1·77	(2·30)	1·56	(+0·74)
1865·38	Dawes	349·5	351·4	−1·9	1·67	1·55	+0·12
1865·43	Knott	348·9	351·3	−2·4	1·70	1·55	+0·15
1865·64	Dembowski	350·4	351·0	−0·6	1·55	1·55	0·0
1866·08	Secchi	350·3	350·3	0·0	1·23	1·55	−0·32
1866·68	Knott	348·2	349·4	−1·2	1·70	1·55	+0·15
1867·06	Dembowski	348·8	348·8	0·0	1·51	1·55	−0·04
1868·61	„	347·1	345·9	+1·2	1·56	1·54	+0·02
1868·69	Brünnow	348·9	345·8	+3·1	1·52	1·54	−0·02
1869·60	Dembowski	346·3	344·7	+1·6	1·58	1·54	+0·04
1870·56	„	343·3	343·1	+0·2	1·72	1·54	+0·18
1870·85	Dunér	343·6	342·65	+0·95	1·53	1·54	−0·01
1871·50	Dembowski	342·1	341·6	+0·5	1·59	1·54	+0·05
1871·74	Knott	337·8	341·2	−3·4	1·69	1·54	+0·15
1872·60	Dembowski	339·2	339·8	−0·6	1·51	1·53	−0·02
1872·67	Knott	(330·1)	339·7	(−9·6)	1·69	1·53	+0·16
1872·78	Wilson & Seabroke	336·7	339·5	−2·8	...	1·53	...
1872·81	O. Struve	341·6	339·5	+2·1	1·47	1·53	−0·06
1873·56	Dembowski	336·2	338·2	−2·0	1·61	1·53	+0·08
1874·62	„	336·3	336·5	−0·2	1·55	1·53	+0·02
1874·70	Wilson & Seabroke	339·1	336·4	+2·7	...	1·53	...
1875·58	Dembowski	333·7	334·9	−1·2	1·58	1·53	+0·05
1875·69	Dunér	336·5	334·7	+1·8	1·52	1·53	−0·01
1875·10	Wilson & Seabroke	335·8	334·7	+1·1	...	1·53	...
1878·65	Dembowski	330·12	332·36	−2·24	1·632	1·53	+0·102
1878·65	Burnham	333·1	329·8	+3·3	1·40	1·53	−0·13
1882·66	Frisby	317·7	323·3	−5·6	1·60	1·54	+0·06
1882·72	Hall	328·3	323·2	+5·1	1·53	1·54	−0·01
1882·84	Engelmann	321·46	323·0	−1·54	1·752	1·54	+0·212
1883·82	„	321·50	321·4	+0·1	1·791	1·55	+0·241
1883·62	Perrotin	322·52	321·7	+0·82	1·667	1·55	+0·117
1883·77	Küstner	320·6	321·5	−0·9	1·75	1·55	+0·20
1885·52	Tarrant	317·83	318·7	−0·87	1·66	1·55	+0·11
1885·90	Engelmann	318·99	318·07	+0·92	1·723	1·553	+0·170
1886·435	Tarrant	318·3	317·2	+1·1	1·71 ["too large"]	1·55	+0·16
1886·65	J. J. M. Perry	315·0	316·9	−1·9	1·6	1·55	+0·05
1887·50	Tarrant	315·92	315·54	+0·38	...	1·56	...

A Revolving Diagonal with Combined Total Reflection and Solar Prism. By William Schooling.

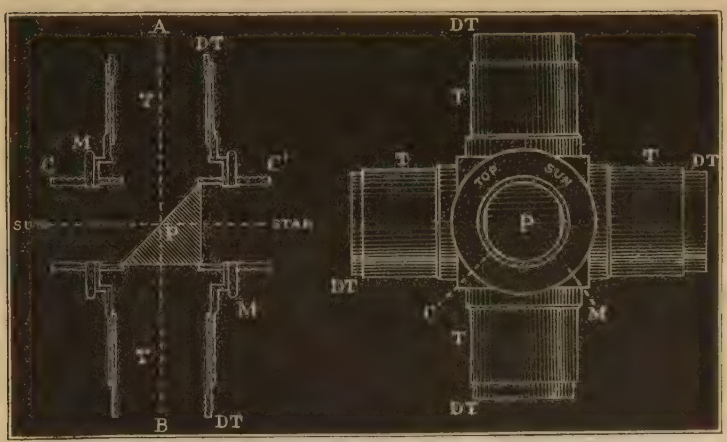
A revolving diagonal enables eye-pieces to be brought into position in rapid succession, just as a nose-piece on a microscope makes it possible to change objectives quickly and easily. It consists of a tube, screwed at each end, for fixing to the telescope, and containing a prism, which acts as a total reflection, or a first surface, prism, according to the end which is presented to the source of light, the tube having holes cut in two places to allow of the passage of the reflected light.

A hollow cube, pierced on all sides, revolves round this tube, and into four sides of the cube are screwed, at right angles to the tube containing the prism, four sockets for receiving the eye-pieces.

By revolving the cube, eye-pieces of various powers can be brought into position quickly and easily, a small stop indicating when the correct place is reached.

The eye-pieces being screwed into short tubes, or adapters, which slide into the sockets, may be focussed by pushing the adapters more or less into the sockets, and as eye-pieces of various powers are successively brought into position, each is in focus without any fresh use of the focussing screw of the telescope.

I believe the revolving arrangement to be a convenience which has not been made before.



P. is a prism fixed in a tube ending at
C. C'. in collars screwed for attaching to telescope.
M. M. are discs with milled edge fixed to the tube, enabling the tube and prism to be held while the eye-pieces are rotated.
T. T. T. T. are tubes attached to a hollow cube that rotates round the tube that holds the prism.
DT. DT. are draw tubes or
DT. DT. adapters holding the eye-pieces and sliding in the tubes T.

When the Sun is to be observed the diagonal is attached to the telescope by the collar C, and the course of the rays is Sun P.A., and by rotating the cube each of the tubes T can be successively brought into the position A. When a star is to be observed the diagonal is attached by C′, and the course of the rays is Star P.B., and, again, any eye-piece is brought into position by rotating.

Notes on Reflecting Telescopes and the Making of Large Discs of Glass for them. By A. A. Common, F.R.S.

In May 1884 I read a "Note on a Method of Reducing the Friction of the Polar Axis of a Large Telescope." In this note I gave a new possible form of reflecting telescope. M. Loewy must have been working at the same subject at the same time, for he gives in the June number of the *Bulletin Astronomique* the identical arrangement, carrying it further and developing the complete Coudé reflecting telescope. In thinking over the best kind of telescope to erect in a situation that is much better than my present observatory, but which is unfortunately much exposed to wind, I have been again disposed to think that a modification of the arrangement of the Coudé telescope as suggested by M. Loewy or of the arrangement suggested by myself—for it is a modification of both—might be used with good effect. This combination, as I have since found, is not new, having been described by a Mr. Benjamin Martin about 150 years ago, according to Dr. Dick, who illustrates it on pp. 288 of his *Practical Astronomer*.

Shortly, it may be described as exactly what M. Loewy describes in the *Bulletin Astronomique* as the complete Coudé reflector, but without the front or outer large plane mirror; that is, a plane mirror pierced with a hole of proper size, placed in front of the concave at a distance somewhat less than its focal length. Optically the arrangement is as given in fig. 1.

There are two ways in which such an optical combination may be used equatoreally: the first, to swing the whole on a polar axis, so that the whole can be moved in declination to any

required point, the polar axis giving the required motion in the other direction. The other to mount the tube carrying the concave mirror rigidly at right angles to the polar axis and to give a power of rotation to the plane mirror in a plane at right angles to the axis of the concave mirror. The last way seems to be in some respects the best, as it keeps the concave mirror in a better position as regards the supports and adjustments. In considering the relative advantages of the Coudé telescope as described by M. Loewy, and such a form as this, it must at once be admitted that there is a considerable sacrifice of the many favourable points of the former, but there is some gain—the most important one, the use of only two reflecting surfaces in place of three, and the consequent greater ease and permanence of adjustment. One of the points sacrificed is the comfort of the observer, but here the loss is not so great as it seems at the first glance, for, by making the equatoreal so that the polar axis is near the plane mirror, counterposing, if necessary, the amount of movement of the eye-end may be made small. The worst feature of such an arrangement is that the telescope must be reversed on the meridian; this is, no doubt, for much work a very serious objection. When I say it must be reversed, I speak with some slight hesitation, as it might be found that the concave mirror could be supported, so that when it passed the vertical it would not perceptibly shift. This involves a rigidity of mounting that would be more or less difficult to obtain. The other way of mounting this form of telescope is not open to this objection, and it retains the relative adjustments of the two mirrors always.

Fig. 2 gives the plan of mounting where the tube is fixed to the polar axis, and the plane mirror rotates. Fig. 3 shows the tube and the plane mirror mounted rigidly together, swinging on the polar axis in declination.

One of the very great advantages is that there will not be any diffraction rays, as in the Newtonian, caused by the supports

of the small mirror. The loss of light would, of course, be the same as in the Newtonian.

The large discs of glass that can be made into mirrors are difficult to obtain, as there seems to be a limit that the makers can deal with at one melting. I suggested some time since to one or two glass makers that it would be possible to build up the discs by having a top and bottom disc of a moderate thickness, say for an 8-foot disc of about 2″ thick, separating these discs by a series of, say, four or five cross strips of glass of a similar thickness, not quite touching, placed crossing each other; then by using a powder of an easily fusible glass, fluxing the whole together in the annealing furnace. This seems to be worth trying, though I cannot say whether it would succeed. I offer the suggestion, as it could be tried by using a thickness of glass that the manufacturers seem to be able to produce easily.

1890 *May* 6.

Observations of Mimas, 1890. By A. A. Common, F.R.S.

On the few occasions when the weather has permitted observation, *Mimas* has been looked for with the 5-foot reflector. The following observations were made :—

	d	h	m	
1890 March	17	12	30	*Mimas* just well past W. elongation.
		12	37	Well past.
		12	45	„ „
April	20	9	30	*Mimas* coming up to W. elongation.
		10	10	At W. elongation.
	29	10	30	*Mimas* in conjunction with E. end of ring; observation difficult, definition bad. (A. Taylor.)

Observations of the Planets Victoria and Sappho, made with the Cambridge Transit Circle in the Year 1889.

(*Communicated by Prof. J. C. Adams.*)

Victoria.

Date of Obs. 1889	True Apparent R.A.			True Apparent N.P.D.			Date of Obs. 1889.	True Apparent R.A.			True Apparent N.P.D.		
	h	m	s	°	′	″		h	m	s	°	′	″
June 25	19	59	11·66	96	38	58·67	July 30	19	32	47·58	94	41	2·98
26	19	58	40·32	96	31	26·34	Aug. 3	19	30	12·94	94	47	1·15
27	19	58	7·25	96	24	8·77	5	19	29	5·25	94	51	12·14
July 5	19	52	49·19	95	33	38·07	6	19	28	34·09	94	53	34·07
11	19	48	5·69	95	6	3·99	15	19	25	17·99	95	21	47·04
18	19	42	13·50	94	45	51·51	17	19	24	56·87	95	29	26·01
23	19	38	4·71	94	39	23·73	29	19	25	54·51	96	20	51·07

Sappho.

Date of Obs. 1889.	True Apparent R.A.	True Apparent N.P.D.	Date of Obs. 1889.	True Apparent R.A.	True Apparent N.P.D.
	h m s	° ′ ″		h m s	° ′ ″
Sept. 10	1 11 25·45	72 7 31·78	Oct. 9	0 55 29·18	76 43 9·62
16	1 9 34·97	72 43 0·59	10	0 54 47·30	76 56 2·81
17	1 9 10·38	72 50 13·58	12	0 53 24·71	77 22 6·24
20	1 7 46·89	73 13 50·42	14	0 52 4·47	77 48 17·10
25	1 4 59·62	73 59 52·97	21	0 47 50 66	79 19 29·02
Oct. 3	0 59 42·22	75 28 20·63	24	0 46 19·71	79 57 16·93
7	0 56 53·28	76 17 40·15	25	0 45 52·15	80 9 34·61
8	0 56 11·10	76 30 21·46	31	0 43 42·17	81 19 19·43

N.B.—The above planets' places are not corrected either for aberration or parallax.

Mean Right Ascensions and Mean North Polar Distances for January 1, 1889, *of Comparison Stars with the Planet Victoria. Observed with the Cambridge Transit Circle.*

Reference Number of Star.	D.M.	Number of Obs.	Mean R.A. Jan. 1, 1889.	Mean N.P.D. Jan. 1, 1889.
	°		h m s	° ′ ″
1	−6–5151	3	19 21 25·30	95 57 22·24
2	−6–5158	3	19 23 2·68	96 24 2·15
3	−5–4985	3	19 24 6·30	95 9 7·97
4	−5–4989	4	19 25 17·96	95 54 13·74
5	−5–4992	5	19 25 40·41	95 21 3·88
6	−5–5006	5	19 27 50·56	94 58 50·71
7	−4–4843	3	19 28 37·76	94 41 25·08
8	−4–4846	3	19 29 20·70	94 33 6·70
9	−5–5021	3	19 30 41·23	95 1 3·72
10	−4–4855	3	19 30 53·49	94 32 44·86
11	−3–4649	2	19 31 22 06	93 43 19·99
12	−4–4861	4	19 31 54·02	94 53 41·71
13	−5–5036	3	19 34 26·95	95 42 8 41
14	−4–4877	5	19 34 53·56	94 17 22·63
15	−4–4883	7	19 35 56·07	94 32 51·00
16	−4–4903	4	19 39 23·76	94 47 23·88
17	−4–4916	5	19 40 59·51	93 56 1·74
18	−5–5060	2	19 41 53·43	95 30 24·59
19	−4–4926	8	19 43 4·53	94 46 19·44
20	−4–4936	2	19 43 44·00	94 48 25·93
21	−5–5075	2	19 44 56·11	94 58 28·26
22	−4–4960	4	19 47 27·31	94 51 33·76

Reference Number of Star.	D.M.	Number of Obs.	Mean R.A. Jan. 1, 1889.	Mean N.P.D. Jan. 1, 1889.
	°		h m s	° ′ ″
23	−5-5099	4	19 48 22·41	95 20 1 33
24	−5-5120	4	19 51 25·88	94 58 55·54
25	−5-5124	4	19 52 3·61	95 29 2 07
26	−6-5320	4	19 52 18·20	96 38 57·47
27	−4-4984	2	19 52 38·11	94 39 18·45
28	−4-4992	3	19 54 57 35	94 36 53·66
29	−6-5339	3	19 55 39 86	96 40 50·12
30	−5-5138	3	19 56 17·67	95 17 50·29
31	−8-5205	3	19 57 4·81	98 0 14·76
32	−5-5144	3	19 57 21·75	94 56 29·82
33	−6-5360	4	19 59 23·84	96 53 58·41
34	−4-5016	2	20 0 44·92	94 44 5·62
35	−7-5169	5	20 0 46·73	97 19 56·40
36	−8-5237	2	20 1 3·74	98 30 0 13
37	−9-5382	7	20 5 8·99	99 10 12·87
			Observations of Stars as Culminators.	
	−8-4887	20	19 6 39·46	98 7 27·71
	−5-4936	20	19 14 37·34	95 37 22·16
	−6-5451	9	20 14 31·50	96 42 29·36
	−3-4888	8	20 19 55·09	93 9 36·40

Mean Right Ascensions and Mean North Polar Distances for January 1, 1889, *of Comparison Stars with the Planet Sappho. Observed with the Cambridge Transit Circle.*

Reference Number of Star.	D.M.	Number of Obs.	Mean R.A. Jan. 1, 1889.	Mean N.P.D. Jan. 1, 1889.
	°		h m s	° ′ ″
	+ 8-101	1	0 37 16·297	81 35 28 90
	+ 7-104	1	0 39 55 566	82 45 45 00
1	+ 8-110	4	0 42 25·234	81 23 2·60
2	+ 9-090	2	0 42 31·14	80 20 50·06
3	+ 11-102	3	0 44 24 38	78 46 24·18
4	+ 9-097	6	0 44 46·70	80 11 35·64
5	+ 11-106	3	0 45 46·15	77 49 7·08
6	+ 9-099	2	0 46 20·45	80 0 7·38
7	+ 12-104	3	0 46 40 08	76 57 15·41
8	+ 9-101	3	0 47 0·60	80 47 55·59
9	+ 10-105	5	0 48 2·91	79 28 47·68

Reference Number of Star.	D.M.	Number of Obs.	Mean R.A. Jan. 1, 1889.	Mean N P.D. Jan. 1, 1889.
	°		h m s	° ′ ″
10	+12–108	4	0 49 12·00	77 45 14·94
11	+13–127	3	0 50 19·74	76 38 58·09
12	+11–118	2	0 50 40·48	77 53 14·85
13	+13–130	2	0 50 52·32	75 49 29·80
14	+ 9–110	3	0 50 59·24	80 35 5·00
15	+11–120	3	0 51 32·89	78 10 13·79
16	+12–119	4	0 52 5·06	76 54 15·67
17	+13–143	3	0 53 53·74	75 59 21·22
18	+10–115	2	0 55 25·64	79 25 0·55
19	+11–135	4	0 55 32·85	78 41 9·56
20	+13–150	4	0 56 43·55	76 20 41·99
21	+15–154	3	0 57 9·68	74 27 33·10
22	+12–126	2	0 57 16·42	77 32 49·69
23	+13–155	2	0 58 0·67	76 39 32·41
24	+14–163	6	0 59 13·77	75 39 4·30
25	+14–168	5	0 59 57·09	75 36 44·07
26	+15–159	2	1 0 29·70	74 16 49·22
27	+15–164	6	1 1 59·67	74 23 45·27
28	+16–116	3	1 2 2·15	73 10 49·31
29	+16–119	4	1 2 34·97	72 56 19·70
30	+14–175	4	1 4 18·25	74 55 1·03
31	+17–166	3	1 5 3·88	72 11 53·84
32	+16–123	3	1 5 10·32	73 48 47·94
33	+13–175	3	1 5 24·12	75 53 54·53
34	+15–175	3	1 6 55·81	73 49 31·44
35	+15–177	7	1 8 13·81	74 27 14·82
36	+16–129	6	1 10 15·81	72 57 7·28
37	+15–185	5	1 11 34·48	74 13 52·08
38	+17–183	8	1 12 26·08	72 0 28·74
			Observations of Stars as Culminators.	
	+10–065	16	0 31 32·027	79 10 28·13
	+15–106	16	0 37 4·282	73 56 36·79
	+10–171	14	1 17 2·193	79 12 46·61
	+16–154	14	1 22 25·994	73 29 43·95

Observations of Comet a 1890 (*Brooks*), *made at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

The observations were made with the East or Sheepshanks equatoreal, aperture 6·7 inches, by taking transits over two cross wires at right angles to each other, and each inclined 45° to the parallel of declination.

Comet a 1890 (*Brooks*).

Greenwich Mean Solar Time.					Observer.	✓−★ R.A.	Corr. for Refraction.	✓−★ N.P.D.	Corr. for Refraction.	No. of Comp.	Apparent R.A.	Log. factor of Parallax.	Apparent N.P.D.	Log. Factor of Parallax.	Comp. Star.
1890.	d	h	m	s		m s	s	′ ″	″		h m s		° ′ ″		
April	16	15	2	55	H.	−1 28·42	0·0	− 8 8·8	−0·4	3	21 9 19·40	9·5530	70 36 42·6	0·7605	*a*
	16	15	7	24	...	−0 45·25	0·0	+ 0 15·5	0·0	5	21 9 21·52	9·5496	70 36 39·4	0·7482	*b*
	29	13	17	7	L.	+0 40·25	0·0	− 8 34·1	−0·4	4	21 1 33·91	9·6132	61 32 31·8	0·7400	*c*
		13	39	41	...	+0 45·00	0·0	+11 17·9	+0·6	6	21 1 33·19	9·6022	61 32 6·7	0·7202	*d*
		13	53	17	..	+3 17·75	0·0	+ 4 19·9	+0·2	2	21 1 32·79	9·5922	61 31 34·4	0·7065	*e*
		13	53	17	...	+2 43·75	0·0	+10 48·4	+0·5	2	21 1 31·99	9·5922	61 31 35·8	0·7065	*f*
	30	13	24	12	H.	−0 20·59	0·0	+ 0 9·2	0·0	6	...	9·6122	...	0·7259	*g*
		13	37	52	...	+3 31·83	0·0	− 3 47·2	−0·2	2	21 0 39·22	9·6032	60 44 26·6	0·7108	*h*
		13	50	4	...	−3 28·33	0·0	+ 0 35·0	0·0	2	...	9·5964	...	0·7013	*i*
May	1	13	20	45	A. D.	+0 42·83	0·0	+ 0 4·5	0·0	6	...	9·6136	...	0·7185	*j*
	1	13	37	35	...	+1 34·33	0·0	+11 35·7	+0·4	3	20 59 31·33	9·6028	59 56 47·2	0·7008	*k*

Assumed Mean Places of Comparison Stars.

	Star's Name.	R.A. 1890·0.	N.P.D. 1890·0.	Authority.
		h m s	° ′ ″	
a	W.B. (2) xxi. 207	21 10 48·52	70 44 37·3	Lamont
b	W.B. (2) xxi. 185	21 10 7·44	70 36 10·0	,,
c	Lalande 40906	21 0 53·86	61 40 50·5	Lalande
d	W.B. (2) xx. 1834	21 0 48·39	61 20 32·3	Weisse's Bessel (2)
e	W.B. (2) xx. 1765	20 58 15·22	61 26 58·4	,,
f	W.B. (2) xx. 1780	20 58 48·43	61 20 31·0	,,
g	B.D. + 29°·4304...	21 0 55	60 45	B.D., vol. iv.
h	Lalande 40763	20 57 7·52	60 47 57·9	Lalande
i	B.D. + 29°·4326	21 4 3	60 43	B.D., vol. iv.
j	B.D. + 29°·4292	20 58 52	59 57	,,
k	W.B. (2) xx. 1761	20 57 57·12	59 44 55·0	Weisse's Bessel (2)

Notes.

May 1. Comet merely a patch of light; sky hazy.

The observations are corrected for refraction, but not for parallax.
The initials A. D., L., and H. are those of Mr. Downing, Mr. Lewis, and Mr. Hollis respectively.

Royal Observatory, Greenwich:
1890 *May* 7.

Catalogue of 918 *Radiant Points of Shooting Stars observed at Bristol.* By William F. Denning.

My observations of shooting stars date from the great display of Leonids in November 1866, though for several years they were merely pursued in a desultory way. In 1870 and at subsequent periods I furnished notes to the British Association Committee on Luminous Meteors, and thereafter adopted a more systematic plan of recording the paths of shooting stars. It was not, however, before the spring of 1876 that I entered upon any lengthy and regular observations with the design of ascertaining the radiant points of the minor showers generally. From 1876 until the present time I have been more or less engaged in gathering materials, though during the years from 1880 to 1883 inclusive I effected little, my leisure being applied to telescopic observations. The following summary shows the number of meteor paths which were registered in each year or, when the results were few, in a series of years :—

Year.		Year.	
1873–4	185 meteors.	1880–4	492 meteors.
1876	786 „	1885	1109 „
1877	1929 „	1886	1162 „
1878	501 „	1887	1809 „
1879	663 „	1888–9	541 „

Total, 1873–89, 9177 meteors.

Several thousands were seen, in addition to these, either during habitual watches or casually ; but many of them belonged to showers which were already sufficiently determined, or were not observed with a degree of accuracy entitling them to record.

Below I give a table exhibiting the time spent in observation in each month, the number of meteors seen and registered, the horary rate of their apparitions, and the number of radiant points derived from them :—

Month.	Hours of Obs.	Meteors Seen.	Meteors Registered.	Horary Rate.	Number of Radiants.
January	58	346	300	6·5	34
February	28	128	119	4·9	11
March	29¾	178	164	6·6	19
April	96¼	580	510	6 6	63
May	58¼	281	274	5·2	25
June	64¼	292	260	4·9	25
July	157¼	1545	1208	11·3	129
August	232¼	3412*	1751	11·3†	178
September	154⅓	1391	1162	10·3	121
October	174¾	1751	1480	11 8	127
November	140½	1351	1244	11·3	114
December	104¼	828	705	8 9	72
Total	1297¾	12083	9177	8·3	918

* Of these 1118 were Perseids. † Perseids omitted.

It will be observed from this table that the bulk of my observations have been conducted in the last half of the year.

The 918 radiant points do not all represent different systems, for many of the most active streams, such as the Lyrids, Perseids, and Leonids, arrested notice in several years, and fresh determinations were made at each recurrence. It is impossible to say how many separate streams are implicated in the 918 positions given in the catalogue, owing to the fact that the visible durations of the great majority of them are not definitely known.

My plan of working may be briefly described as follows:—All the observations were made in the open air and from the garden adjoining the house. Attention was almost invariably given to the eastern sky. In mild weather I sat in a chair with the back inclined at a suitable angle; but on cold, frosty nights I found it expedient to maintain a standing posture, and sometimes to pace to and fro, always, however, keeping the eyes directed towards the firmament in quest of meteors.

Soon after I became regularly occupied in these observations I recognised the utility of adopting some means to aid the eye in fixing the precise *directions* of the apparent paths of meteors. I found that, while noting the position of the beginning and end points of a flight, a feeling of uncertainty would arise as to the observed slope of path. Meteors are usually so quick in their motions, and so rarely appear exactly in that place towards which the observer happens to be looking at the instant, that they only permit very hurried, and often imperfect, views, so that, when attributing definite positions, he becomes conscious that his estimate is, to some extent, doubtful, especially so in cases where the meteors fall in a comparatively bare region of the sky. Moreover, the observer's eye, in retracing and assigning the path-directions relatively to the stars, has a tendency to inaccurate estimation, and becomes, therefore, an untrustworthy guide, for these natural impressions of direction sometimes differ materially from those obtained by the projection of a perfectly straight wand upon the meteor's courses. I therefore found it essential to rely upon the latter contrivance as a help and corrective to the eye in ascribing the lines of flight. When a meteor was seen the wand was immediately projected upon its track, and the position quickly noted and reproduced on an 18-inch celestial globe. The time, magnitude, appearance, beginning-point, and probable radiant were then written down, and other details left to be filled in on the following day, when all the paths were carefully compared and their provisional radiants derived. During the actual progress of these observations it is necessary to utilise time to the utmost degree, for, unless the observer exercises celerity in registering the flights, he will, during the short intervals his attention is diverted from the sky, lose many important meteors. In any case some must escape his vigilance; but the number will not be large on

ordinary nights if he does the work of charting as rapidly as is consistent with precision.

My observations were almost equally distributed between the morning and evening hours, and were usually made between the third and first quarters of the moon. (In the presence of moonlight meteors are commonly rare, and one tires of watching for them. There is, perhaps, no influence more effective than a bright sky in obliterating meteor showers.) At the end of each period of observation I finally discussed the materials collected and deduced the radiants. In some instances a very definite little shower would be manifested from a single night's work, but I generally found it advisable to combine the paths recorded on several dates in order to obtain satisfactory positions.

The average length of path of all the meteors I have registered is 10·9 degrees.

The mean horary number (8·3) of meteors as given in my table is less than would be observed from a place where there is no interference from the light and smoke of a large town. My observations since 1883 were made in a neighbourhood rather subject to fogs and surrounded with gaslight. Before 1883 my position (at Ashley Down) was far more favourable, being much less affected by such influences. The following figures will show to what extent difference of locality may affect results of this nature :—

Year.	Duration of Obs.	Meteors seen.	Horary Number.
1877	230 hours	2250	11 4*
1887	278 „	2031	8 2

From places where there is much artificial illumination of the air small meteors elude detection. A little fog is also a serious hindrance, owing to its capacity of reflection. The above figures exhibit a balance of three meteors per hour in favour of the best station. Country places are obviously far better than towns for observations of this kind, and at sea the conditions are even better still.

As to the relative numbers which appear during the night, I find the maximum is attained between 2 and 3 A.M., when the rate is nearly double that observed in the early hours of the evening.

While watching for meteors I frequently noticed two of these bodies would appear at nearly the same time and from the same radiant. The probable explanation in such cases is that the two objects originally formed one mass which suffered disruption owing to the vicissitudes encountered in planetary space.

The intention of my observations being to determine radiant points, I have made few computations as to the heights of either

* In deriving the horary numbers I have made allowances for time spent in registering the tracks, which must be subtracted from the aggregate duration of the observations.

fireballs or shooting stars. I gave, however, two lists of such results in the *Journal of the Liverpool Astronomical Society* for March 1888 and April 1889. Adding to these a few meteors, of which duplicate observations were made in 1889, I find the following average values for thirty-eight instances, including fireballs and shooting stars :—

Beginning height 71·1 miles.
End height ... 48·2 „

These results agree satisfactorily with the values assigned by other computers. From a comparison of a large number of other similar results I deduced the following general average :—

Beginning height 76·4 miles (683 meteors).
End height ... 50·8 „ (756 „).

But, if fireballs and shooting stars are separated, I find the usual heights at disappearance are: fireballs, thirty miles; shooting stars, fifty-four miles.

In the catalogue I have affixed the number of meteors observed from each radiant. With regard to the more feeble showers giving only three, four, or five meteors, I would remark that I regard them as the most interesting, and in a great number of cases as not the least certain of all. Great care has been taken to avoid erroneous positions. I have only included feeble radiants when the circumstances were special. Some of them include a stationary meteor, others a meteor observed at two stations. Others again are confirmed by another radiant of nearly similar date and place, and a proportion of them being near the horizon or in an isolated position could be determined from very few meteors. The small number of meteors to some of the radiants is not therefore any sign of their doubtful character. It is simply attributable either to feebleness in the systems themselves or to the unfavourable situation of their radiants. The average number of meteors to each position included in the catalogue is about nine.

The minor systems generally are of extreme tenuity, but the Earth encounters large numbers of them. Their radiants are only to be satisfactorily revealed by long-sustained watching and by undeviating exactness in recording their individual meteor flights. A finer climate than that of England would offer great advantages in a practical research of this kind and enable more productive materials to be obtained, but the result in the main would be similar, as indicating the extraordinary number of feeble and scarcely discernible systems of shooting stars. Could many observers combine to secure data of uniform accuracy and character, the investigation of these weak streams might be simplified: but there seems little prospect that such an arrangement can be effectively carried out.

A proportion of the showers represented in the catalogue apparently discharge not more than one meteor in five or seven hours, but I regard the radiant points as quite trustworthy, no means having been omitted to gather reliable positions, and to avoid all such as appeared due to the accidental intersection of the paths. Observing for thirty-three hours during the latter part of December 1886, I adopted a radiant at 77°+32°, which I thought sufficiently established, though it had supplied only five meteors during the whole period mentioned. The opinion was justified, as I found a few days later, for one of the most conspicuous of its meteors had been very carefully and fully observed from Sidmouth, and on computing its real path by comparison with the Bristol observation, the radiant above mentioned received exact corroboration.

I have frequently found that radiant points are very sharply defined, and believe that diffused positions are very often the outcome of inaccurate observation rather than a real feature of meteor swarms. The large area of radiation, manifested by the great storm of Andromedes in 1885, may be regarded as exceptional. When I began observing that shower on the early evening of November 27 I was immediately struck with the indefinite character of its radiant, and some trouble was experienced in assigning a good centre. Yet in regard to other showers, far less rich, a similar difficulty rarely presents itself. Undoubtedly a small proportion of the meteors diverging from many systems appears to be a little erratic and occasions some perplexity in the observer's mind as to the source of such discordances and how he may safely adjust his materials; but as a rule he will find the centres indicated with fair, if not excellent, precision. I have not infrequently marked about ten meteors from a minor stream, the paths of which have all intersected at a point. In other instances seven out of ten meteors would converge upon a sharp focus, while three others, unquestionably from the same system, proved erratic to the extent of 3° or 4°. Errors in noting the directions induce some disagreements of this sort, but there is no doubt that a certain proportion of meteor flights really deviate several degrees from the radiant centres indicated by the bulk of the paths. The allotment of individual meteors to their respective radiants becomes therefore a critical feature in these reductions, and one which requires that the observed appearance of each meteor should be carefully considered before it is disposed of.

One of the most singular issues of my observations is that a comparatively large number of the showers detected apparently endure for a much longer period than can be admitted on the prevalent theory of their cometary origin. But in the catalogue I have confined the showers to single nights, and in another column specified a few other dates of activity. The method of attributing the radiants to the epochs of their maximum display has much to recommend it. It is concise and definite, and readily permits comparisons with the computed dates and radiant points

of comets. Moreover, it is consistent with theoretical views, according to which extreme brevity must form an essential feature of stationary radiant points. But it is in the highest degree probable that there is not a single meteoric display in the heavens but has a longer duration than twenty-four hours. The whole question as to the length of visibility of radiant points requires thorough investigation. A few of the positions become rapidly displaced amongst the stars, while many others remain fixed. The Perseids, it is certain, begin to fall as early as July 8 from a radiant at 3°+49°, and they do not cease until August 22, when the centre has passed to the point 78°+58°. On August 10, when the maximum is attained, the radiant is at 46°+57°, corresponding with that of Comet III. 1862. The Lyrids of April also exhibit a radiant which quickly changes its place during the few nights of its operation. On the other hand, the Orionids of October gave no evidence of a similar variation, for though the shower is maintained for three weeks (October 9–29) the radiant is all the time constant at about the point 92°+15°.

As to the fact of stationary radiation, which I fully recounted in a paper published in the *Monthly Notices* for December 1884, I have endeavoured to test it by about 5000 observations obtained during the five years which have elapsed since that time. These new materials appear to support the conclusions previously arrived at. In many cases the same radiant point (allowing for very trifling errors inseparable from the observations) is persistent during several months. This attitude is very unmistakable in its character and convincing in its proofs. In my paper above referred to, I mentioned the successively observed positions for a remarkably long-enduring shower between α and β *Persei*, and of this particular stream, or succession of streams, I have secured several fresh determinations. It is to be regarded as one of the best instances of an apparently stationary radiant, and it may be interesting to append a summary of all my observations relating to its appearances at different times of the year :—

1877 July 20	47°+45°		1885	Sept. 15	48°+43°
1884 July 23–25	48+43		1877	Sept. 15–16	47+45
1886 Aug. 2–10	48+43		1886	Sept. 22–30	48+44
1888 Aug. 5–14	48+44		1887	Oct. 17–24	47+44
1877 Aug. 3–16	46+45		1879	Oct. 20	45+46
1884 Aug. 19–21	46+44		1879	Nov. 12–14	48+43
1879 Aug. 21–23	46+47		1877–86	Nov. 27–Dec. 8	48+42
1887 Aug. 30	46+43		1886–8	Dec. 28–Jan. 11	47+44
1887 Sept. 12–24	47+43		1876–87	Feb. 23–Mar. 12	47+45

The mean of the eighteen radiants is at 47°+44°, and the whole interval over which they extend, from July 20 to March 12, = 234 days.

I have also strongly suspected this radiant at additional periods to those given, but the number of observed paths has not been sufficient to define it with absolute certainty. The positions in the table exhibit a very suggestive resemblance, and some of them it will be noticed are identical. In July and August these α–β Perseids are somewhat conspicuous, they move *very swiftly*, and leave bright streaks. In fact, they closely resemble the meteors of the great Perseid shower. In September the motions are still *very swift*, but the meteors are then devoid of streaks, except in the more brilliant instances. In October the speed has palpably slackened, my description of the flights being *moderately swift*, while at the middle of November I estimated them as *rather slow*. At the end of that month and early in December my records give *slow* and *very slow*, and this also applies to the meteors of this radiant, seen between December 28–January 11, and February 23–March 12.

This position between α and β *Persei* has been recognised at various epochs of the year by several other observers as the well-defined focus of a meteor shower. I have seen but little of it during the opening months, so it is satisfactory to find that it was observed by Heis (January 2–26 at 45°+44°), Zezioli (January 11, 47°+40°), and Greg and Herschel (March 1–15, 50°+47°).

I may also make reference in this place to some observations of a prolonged shower which I traced during the very clear summer months of 1887 :—

June 10–28	335°+57°	10 meteors
July 14–23	334+58	6 „
Aug. 6–25	334+58	10 „
Sept. 17–22	335+58	12 „

There is also a display which indicates unusually definite radiation in September and all through the autumnal months following. The mean position of this is at 155°+40° near the stars μ, λ of *Ursa Major*. I allude to these isolated cases merely as furnishing good examples of a rather numerous class, of which I give a selected list at the end of the catalogue.

I refer to the existence of apparently stationary radiants merely as a fact of observation. The evidence supporting them is scarcely of a character to be disregarded. I have no theory whatever to substantiate by upholding a feature so anomalous, and confidently leave it for elucidation by future observers. There must, of course, be little parallelism of real direction, and considerable differences of orbit in the meteors of these long-enduring (or successively-recurring) displays, but in certain cases

at least the phenomena may be induced by the effects of planetary perturbations upon very wide streams. The subject both in its observational and theoretical bearings demands much more investigation.

It is certain that, inasmuch as the heavens are so thickly studded with radiant points, there must happen many close agreements in the apparent places of showers successively displayed, but which have no real physical association. This is proved by the circumstance that during the autumnal months there are several star showers directed from near η *Persei*, which is precisely the centre of the August Perseids on the date of its maximum. And there are some very definite radiants in July, August, and October from the identical point near γ *Andromedæ* which furnishes the Andromedes of Biela's Comet. But there can be no doubt that these accordances in the apparent astronomical radiant points are purely accidental. In the many other instances, however, afforded by the minor showers the facts are far more striking and must certainly arrest the attention of every observer who becomes deeply involved in accurate observations of shooting stars. In the last column of the catalogue I have notified a few comparisons with Lieut.-Colonel Tupman's "Catalogue of Observed Radiant Points" of shooting stars published in the *Monthly Notices*, vol. xxxiii., p. 300–5. Thus "T. 1," affixed to my first radiant, is intended to show that it is identical with Tupman's radiant No. 1.

Catalogue of Radiant Points of Shooting Stars.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
1	1884	Jan. 1	222	+49	...	6	=913, 2, 5, 6, and 8. Quadrantids. T. 1.
2	1879	1	230	+51	...	14	Bright, white. Quadrantids.
3	1886	2	119	+16	Jan. 4	7	Rather swift, bright.
4	1886	2	167	+ 4	Dec. 31, Jan. 4	5	Very swift, streaks. T. 2.
5	1880	2	228	+54	...	19	Slowish, long paths. Quadrantids.
6	1886	2	228	+52	Dec. 31	8	Rather swift, bright. Quadrantids.
7	1877	4	57	−12	Jan. 8	7	Bright, very slow.
8	1877	4	231	+54	...	4	Not very swift, long. Quadrantids.
9	1886	5	72	+14	Jan. 2, 4, 8	5	Swift.
10	1886	5	140	+57	Jan. 2, 4	6	Swift, very short.
11	1886	8	329	+60	Dec. 29, Jan. 4	5	Slow, bright, trains.
12	1877	9	84	+74	Jan. 4, 6, 11	6	Swift, short.
13	1877	9	146	+ 4	Jan. 17	4	Slow, =900. T. 3.
14	1877	9	209	+67	Jan. 11	7	Swift, white.
15	1877	9	221	+42	...	6	Swift, streaks.
16	1886	11	220	+13	Jan. 4	7	Very swift, streaks.
17	1877	11	248	+73	...	7	Very slow, yellow, trains.
18	1877	14	130	+44	Jan. 17	11	Rather swift, bright.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
19	1877	Jan. 14	179	+47	Jan. 17, 20, 21	9	Swift.
20	1877	14	209	+15	Jan. 20	5	Very swift, streaks.
21	1877	14	211	+ 4	Jan. 20	5	Very swift, streaks.
22	1877	14	250	+25	Jan. 17	10	Swift, short, streaks.
23	1877	14	260	+45	Jan. 17	6	Short, faint.
24	1877	17	160	+28	Jan. 19	6	Swift, white.
25	1877	17	295	+53	Jan. 14	20	Slowish, bright, trains.
26	1887	19	253	+56	Jan. 14, 17	5	Very slow, yellow.
27	1887	19	261	+63	Jan. 25	4	Rather slow.
28	1877	20	220	+52	Jan. 14	5	Rather slow.
29	1877	20	226	− 2	Jan. 2, 1884	...	Swift, streaks.
30	1877	22	208	− 8	Jan. 19, 20, 25	5	Very swift, streaks, =37.
31	1887-9	25	131	+32	Jan. 29, Feb. 1	4	Rather swift.
32	1887	25	180	+24	...	5	Very swift.
33	1887-9	29	213	+52	Jan. 25	5	Very swift.
34	1889	Feb. 1	211	+69	Feb. 4	4	Slow, short.
35	1877	4	61	+28	Feb. 5	4	Rather swift.
36	1877	4	105	+29	Feb. 2	5	Very slow.
37	1877	15	210	−13	Feb. 21	5	Swift, streaks, =30. T. 6.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
38	1877	Feb. 15	236	+11	Feb. 20	10	Very swift. T. 10.
39	1877	15	261	+ 4	Feb. 20	4	Swift, streaks. T. 16.
40	1877	16	167	+ 5	Feb. 21	6	Slowish, streaks.
41	1877	20	181	+34	...	8	Very swift, bright. T. 4.
42	1877	20	234	+32	...	12	Swift.
43	1877	20	263	+36	Feb. 21	5	Swift.
44	1877	20	285	−15	...	...	Very swift, long.
45	1876–87	Mar. 1	47	+45	Feb. 23–27, Mar. 12	4	Very slow.
46	1886	4	176	+ 9	Mar. 3	4	Slowish, =48.
47	1877	8	189	+26	...	6	Slowish, faint.
48	1877	14	175	+10	Mar. 15	5	Slowish, bright, =46.
49	1877	14	218	+36	...	6	Slow.
50	1877	14	244	+50	...	6	Swift.
51	1877	14	250	+54	...	4	Swift.
52	1877	14	263	+48	...	6	Swift, streaks.
53	1877	14	277	+25	...	5	Not very swift.
54	1877	14	280	−14	...	...	Very swift, streaks.
55	1877	16	316	+46	Mar. 18	...	Slow, starlike.
56	1876	17	184	+54	Mar. 12	6	Swift.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
57	1877	Mar. 17	252	+12	...	3	Swift.
58	1887	18	316	+76	Mar. 16, 24, 27, 28	5	Slow, bright.
59	1887	23	190	+20	Mar. 21, 24, 28	5	Swift.
60	1887	24	161	+58	Mar. 23, 25, 27	7	Swift.
61	1887	25	175	+20	Mar. 13, 27	5	Slow.
62	1887	27	229	+32	Mar. 25	6	Swift, faint.
63	1887	28	263	+62	...	5	Slowish.
64	1876	Apr. 11	230	+38	Apr. 13, 22	8	Slow.
65	1876	15	194	+30	...	10	Small.
66	1876	15	207	+48	Apr. 14, 16	7	Swift, short.
67	1877	16	210	−10	Apr. 7	5	Swift, streaks.
68	1876	16	241	+24	Apr. 17, 22	8	Rather swift.
69	1887	17	165	− 6	Apr. 18	5	Very slow.
70	1885	18	181	+35	...	4	Very slow, orange.
71	1885	18	226	± 0	Apr. 19, 20	4	Very slow, =79. T. 32.
72	1885	18	260	+33	...	6	Swift, bright, streaks. Lyrids.
73	1887	18	213	+53	Apr. 17, 19	7	Swift, short.
74	1887	18	231	+17	Apr. 19, 25	10	Swift, short, =98.
75	1887	18	266	+33	...	4	Swift, streaks. Lyrids.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
76	1887	Apr. 18	327°	+48°	Apr. 19, 20	4	Slow, bright.
77	1885	19	213	+ 9	Apr. 18, 20	4	Very slow.
78	1887	19	218	+33	Apr. 18, 20, 25	5	Slow, bright.
79	1877	19	228	− 2	Apr. 16	5	Slow, =71. T. 32
80	1885	19	236	+62	Apr. 20	7	Slow.
81	1887	19	238	+46	Apr. 17, 18, 20, 25	5	Swift, short.
82	1887	19	254	+57	Apr. 18, 25	5	Slowish, short.
83	1877	19	255	+50	...	5	Swift.
84	1877	19	260	+ 2	...	4	Swift, white.
85	1877	19	267	+21	...	6	Swift, =119.
86	1885	19	268	+33	...	10	Swift, bright. Lyrids.
87	1877	19	269	+37	Apr. 16	7	Rather swift. Lyrids.
88	1887	19	269	+31	...	5	Swift, streaks. Lyrids.
89	1887	19	280	+47	Apr. 17, 25	4	Slow.
90	1877	19	286	+ 5	...	12	
91	1877	19	289	−15	Apr. 16, 25	5	Swift.
92	1877	19	298	+25	Apr. 16	6	Swift, streaks, =121.
93	1877	19	303	+13	...	8	
94	1877	19	315	+38	...	10	

No.	Year.	Dat.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
95	1887	Apr. 20	189	+20	Apr. 12, 25	7	Very slow.
96	1873	20	221	+20	Apr. 19, 21	9	Swift.
97	1885	20	226	+41	...	4	Not swift.
98	1885	20	230	+17	Apr. 19	5	Slowish, short, =74.
99	1887	20	235	−15	Apr. 16, 19, 21	5	Slowish, long.
100	1874	20	242	+25	...	7	
101	1878	20	251	+31	Apr. 26	6	Very swift.
102	1884	20	269	+33	...	17	Slowish, short. Lyrids.
103	1887	20	271	+33	...	7	Very swift, streaks. Lyrids.
104	1878	20	272	+32	Apr. 21, 22	13	Swift. Lyrids.
105	1879	20	272	+33	...	8	Lyrids.
106	1873-4	19, 20	274	+37	Apr. 21	32	Swift, bright. Lyrids.
107	1885	20	274	+33	...	14	Swift, bright. Lyrids.
108	1879	20	286	+24	Apr. 19	4	Very swift, streaks.
109	1885	20	296	± 0	Apr. 18	4	Very, very swift, =143.
110	1885	20	299	+24	Apr. 18, 19	5	Very swift, streaks, =121.
111	1885	21	277	+67	Apr. 16, 20, 22	6	Swift, short.
112	1873	21	283	+59	...	5	Swift.
113	1878	21	293	+43	Apr. 22	4	Swift.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
114	1876	Apr. 22	142	+49	Apr. 21	6	Swift.
115	1876	22	207	− 7	...	5	Slow.
116	1876	22	223	+45	...	5	
117	1878	22	263	+62	Apr. 20, 21, 26	6	Swift.
118	1886	24	189	+58	Apr. 19, 26	6	Slow.
119	1887	25	272	+21	Apr. 18, 20, 27	12	Swift, short, =85.
120	1887	25	284	+21	Apr. 19	4	Swift, streaks, =108.
121	1887	25	302	+23	Apr. 19	4	Swift, short, =92 and 110.
122	1886	26	160	+59	Apr. 24, 30	5	Slow.
123	1886	26	255	+37	May 1, 3	5	Slowish.
124	1887	26	260	+62	Apr. 19	6	Slowish, =138 and 140.
125	1886	27	241	+61	Apr. 21, May 3, 4	8	Swift.
126	1886	30	257	+25	Apr. 25, May 3	4	Slow, trains.
127	1886	May 1	239	+46	May 4	8	Swift.
128	1885	3	195	+45	Apr. 24	10	Slow.
129	1886	3	265	+77	Apr. 26	5	Slow.
130	1886	3	345	+37	May 4	3	Slow.
131	1886	5	228	+33	May 1, 8	5	Rather slow.
132	1886	5	234	+10	Apr. 27, May 3, 4	8	Slowish.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
133	1886	May 5	254°	−21°	Apr. 30, May 6	5	Slowish.
134	1886	5	327	+34	Apr. 30, May 9	4	Very swift.
135	1886	6	337	− 2	Apr. 30, May 1–5	11	Swift, streaks. T. 33.
136	1877	7	219	+17	...	4	Slowish.
137	1877	7	244	+ 7	May 2, 3, 11, 13	11	Slowish.
138	1886	8	264	+64	Apr. 30, May 5, 6,	6	Swift, = 124 and 140.
139	1885	11	231	+27	May 7, 14–16, 18	8	Slow, short, small.
140	1885	11	262	+64	May 14	4	Slow, faint, = 124 and 138.
141	1887	13	255	+56	May 16	4	Slow.
142	1885	14	314	+15	May 13, 16	5	Swift, streaks.
143	1877	15	294	± 0	...	6	Very swift, = 109.
144	1877	15	304	+ 7	May 6	5	Swift, white.
145	1877	17	283	+55	...	4	Swift.
146	1877	17	354	+41	May 15	4	Not swift, streaks.
147	1886	29	264	+64	May 28, 30	4	Slowish, = 155.
148	1886	29	333	+27	May 30, June 4, 9	6	Swift, streaks.
149	1877	30	20	+58	...	4	Bright, streaks.
150	1886	30	290	+60	...	5	Slow, yellow.
151	1886	30	304	+22	...	4	Swift, = 121 and 167.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
152	1886	June 4	313	+60	...	3	Very swift, streaks, =156.
153	1885	10	261	+ 5	June 3, 9, 13	7	Very slow.
154	1885	11	257	+32	June 10, 23	5	Slow.
155	1885	13	262	+64	June 9, 10	5	Slow, faint, =147.
156	1885	13	310	+61	...	4	Swift, streaks, =152.
157	1885	13	345	± 0	June 11	3	Very swift, bright.
158	1887	15	285	+23	June 12, 17, 18, 21	11	Slowish.
159	1887	15	291	+52	June 10, 13, 17	8	Swift, small.
160	1887	17	252	+11	June 19, 20, 23	7	Slow.
161	1887	17	268	−24	June 10, 14, 19, 20	5	Very slow, bright.
162	1887	17	270	+47	June 13, 19, 21	5	Slow, bright.
163	1877	17	285	+32	June 15	5	Swift.
164	1887	17	295	+40	June 18, 23, 26	6	Not slow, =176.
165	1877	17	302	+64	June 14	5	Swift, short.
166	1887	18	274	+69	June 11, 12, 15, 19	9	Swift, short.
167	1887	18	302	+24	June 13, 20, 22	11	Rather swift, =151.
168	1887	20	280	+43	June 17, 21, 23	10	Swift, small.
169	1887	20	335	+57	June 10, 11, 28	10	Swift.
170	1887	21	290	+27	June 17, 25	6	Rather slow.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
171	1887	June 23	40	+56	June 14, 19, 25	4	Swift, streaks.
172	1887	25	238	+47	June 11, 21, 23, 26	7	Slow, small.
173	1887	26	213	+53	June 14, 28	4	Swift, bright.
174	1887	26	354	+39	June 14, 17, July 4, 6	9	Very swift, streaks.
175	1873	28	164	+57	June 25, July 8	5	Slow.
176	1886	28	294	+39	June 26, July 1, 4–6	9	Slow, very short, =164.
177	1886	July 1	219	+72	June 28	5	Swift, =187.
178	1886	1	339	+31	July 4, 5	4	Swift, streaks.
179	1886	4	303	+24	June 30, July 5, 7	6	Swift, =167.
180	1886	5	21	+23	July 6	4	Swift, streaks.
181	1886	5	315	+17	July 4, 6	4	Swift.
182	1886	5	316	+46	July 2, 6	5	Swift, short, =207.
183	1877	6	284	−13	July 12	5	Slow, =204. T. 36.
184	1886	6	313	+60	July 1, 4	4	Slow.
185	1877	7	4	+35	...	5	Very swift, streaks, =193.
186	1877	7	333	+26	July 6	11	Swift, white.
187	1875	7	344	+27	...	...	=178.
188	1888	8	3	+49	July 11	6	Very swift, streaks. Perseids.
189	1885	8	245	+52	July 11, 12	7	Very slow, yellow.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
190	1888	July 8	310°	+79°	July 12	5	Swift, small, short.
191	1885	9	266	+63	July 12, 13	5	Slow.
192	1885	9	347	± 0	...	...	Swift, streaks.
193	1877	11	5	+35	...	6	Very swift, streaks, =185.
194	1877	11	280	+57	...	5	Swift.
195	1877	11	290	+43	...	8	Swift.
196	1885	11	303	+39	July 9, 12	5	Slowish.
197	1888	11	319	+22	July 13	6	Rather swift.
198	1877	11	349	+53	July 12	10	Swift.
199	1877	12	6	+53	...	6	Swift, streaks, =219.
200	1877	12	7	+37	...	5	Very swift, =185 and 193.
201	1888	12	28	+30	July 11, 13	5	Swift, bright streaks.
202	1877	12	36	+47	...	6	Swift, streaks.
203	1877	12	271	+ 8	...	5	Very slow, orange.
204	1885	12	280	−14	July 9, 11, 13	7	Very slow, trained, =183.
205	1885	12	289	+31	July 9, 13	5	Very swift, short.
206	1877	12	295	+85	July 16, 17	6	Not swift.
207	1877	12	315	+48	July 11, 13	8	Swift, =182, 216.
208	1885	12	329	+36	July 9, 13, 14	8	Rather swift, streaks.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
209	1877	July 12	338°	+10°	July 16, 17	10	Swift, bright, =225.
210	1885	13	6	+11	July 12	5	Very swift, streaks. T. 49.
211	1885	13	11	+48	July 11, 14	5	Very swift, streaks. Perseids.
212	1885	13	255	+37	July 12, 14, 16	6	Slowish, faint, =222.
213	1885	13	271	+21	July 12, 14	8	Slow, faint.
214	1885	13	290	+60	July 8, 9	5	Slowish.
215	1885	13	303	+24	July 9	4	Swift, faint, short.
216	1885	13	314	+47	July 14	5	Very swift, short, =207.
217	1885	14	285	+42	July 13, 17	5	Swift, =257.
218	1877	16	5	+35	...	5	Very swift, streaks.
219	1877	16	5	+52	...	11	Very swift, streaks, =199, 221.
220	1876	16	284	+57	July 15, 18	21	Very swift, faint.
221	1877	17	7	+53	...	5	Swift, streaks, =219.
222	1877	17	258	+37	...	6	Swift, =212.
223	1877	17	298	− 8	...	5	Swift. T. 37.
224	1887	18	310	+ 9	July 14, 19, 22	9	Rather swift.
225	1887	18	333	+12	July 21, 22, 23	17	Swift, =209.
226	1887	19	19	+51	...	4	Swift, streaks. Perseids.
227	1873	19	267	+49	July 15, 20	5	Swift, =247, 256, 284.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
228	1887	July 19	314°	+48°	July 20, 21, 23	5	Swift, short, =216.
229	1876	19	330	+70	July 20	18	Swift, short.
230	1887	19	334	+58	July 14, 18, 22, 23	6	Swift.
231	1877	20	47	+45	...	5	Swift, streaks, =246.
232	1877	20	317	−11	...	13	Slow. T. 44.
233	1877	20	350	+37	July 12, 17	6	Swift, =239.
234	1878	21	50	+75	July 26, 27	5	Swift, short.
235	1876	21	298	+ 2	July 23	14	Not slow.
236	1887	22	16	+31	July 27, 29, Aug. 1	8	Swift, streaks.
237	1887	22	20	+65	July 27, Aug. 1	6	Swift, streaks, short, =244.
238	1887	22	25	+52	...	5	Swift, streaks. Perseids.
239	1887	22	351	+38	July 18, 31	6	Swift, =226, 249
240	1887	23	25	+52	...	4	Swift, streaks. Perseids.
241	1884	23	75	+31	...	4	Slowish, streaks, long.
242	1884	23	301	−14	July 25	8	Very slow, =268.
243	1887	23	335	+49	July 16, 18, 19, 27	16	Very swift, short, =310.
244	1876	24	18	+63	July 19, 20, 21, 23	28	Swift, streaks, =237.
245	1884	24	260	+68	...	5	Short, swift, =255.
246	1884	25	48	+43	July 21, 23, 24, 27	15	Swift, bright, streaks, =231.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
247	1884	July 25	275°	+47°	...	5	Swift, short, faint, =227, 284.
248	1878	26	3	+35	...	5	Swift, streaks, =250.
249	1878	26	332	+37	July 25	11	Slowish.
250	1878	27	6	+34	...	5	Swift, streaks, =248.
251	1889	27	8	+52	July 26, 30	6	Swift, streaks.
252	1878	27	28	+28	July 27, 28, 31	7	Swift, streaks.
253	1878	27	28	+36	July 26, 28, 31	12	Swift, streaks, =279.
254	1887	27	29	+54	...	5	Swift, streaks. Perseids.
255	1887	27	260	+69	July 28, 29	7	Not swift, =245.
256	1889	27	271	+47	July 23, 31, Aug. 3	5	Slow, =247, 284.
257	1878	27	284	+44	July 28	4	Slow, brilliant, =217.
258	1878	27	354	+42	July 26	7	Slowish, faint, =276.
259	1878	28	7	+36	...	5	Swift, streaks, =250. T. 45.
260	1878	28	18	+58	...	8	Swift, streaks, =278.
261	1878	28	21	+22	...	5	Very swift, short.
262	1883	28	27	+55	...	10	Swift, streaks. Perseids.
263	1887	28	30	+55	...	10	Swift, streaks. Perseids.
264	1878	28	32	+53	July 27	10	Swift, streaks. Perseids.
265	1879	28	32	+53	...	9	Swift, streaks. Perseids.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
266	1878	July 28	33°	−20°	...	...	Swift, bright, streaks.
267	1887	28	34	+18	July 27, 29, 31	8	Swift, streaks, =289.
268	1878	28	305	−15	...	5	Very slow, =242.
269	1887	28	314	+14	July 21, 27	7	Slowish.
270	1878	28	332	+27	July 27, 30, 31	8	Very swift, faint.
271	1878	28	333	+18	July 26, 27, 30, 31	8	Swift, faint.
272	1883	28	337	−11	...	18	Slow, trained, long. Aquarids.
273	1887	28	337	−12	July 25, 27, 29, 31	37	Slowish, long. Aquarids.
274	1879	28	338	−14	...	14	Slow, bright, long. Aquarids.
275	1878	28	341	−13	July 27, 30, 31	54	Slow, bright, long. Aquarids.
276	1877	28	350	+37	Aug. 4, 7, 10	5	Swift.
277	1878	29	7	+37	...	5	Swift, streaks, =259.
278	1887	29	21	+57	July 20, 28, Aug. 1	9	Swift, streaks, =260.
279	1879	29	30	+37	...	6	Swift, streaks, =253.
280	1887	29	31	+54½	...	10	Swift, streaks. Perseids.
281	1887	29	43	+39	July 31	5	Swift, streaks.
282	1880	29	257	+64	...	4	Slow, brilliant, =283.
283	1887	29	263	+61	Aug. 2	4	Slowish, =282.
284	1887	29	269	+49	July 20, 22, 23, 31	13	Swift, =256.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
285	1887	July 29	322	−11	July 22, 27	5	Slowish, =232. T. 44.
286	1878	30	6	+35	...	6	Swift, streaks, =277.
287	1878	30	12	+52	July 25, 26, 30	13	Swift, streaks.
288	1878	30	20	+ 8	...	5	Swift, streaks.
289	1878	30	31	+18	July 31	4	Swift, streaks, =267.
290	1878	30	32	+53	July 31, Aug. 1	53	Swift, streaks. Perseids.
291	1878–89	30	134	+78	July 27, 28, 31	5	Slow.
292	1877	30	147	+62	Aug. 7	3	Slow, bright, yellow.
293	1885	31	5	+10	July 27, Aug. 1	6	Swift, streaks, =294.
294	1878	31	7	+11	Aug. 1	9	Very swift, streaks, =293.
295	1878	31	11	+47	July 30	13	Swift, streaks.
296	1878	31	12	+70	July 25, 29, Aug. 1	16	Swift, faint.
297	1887	31	35	+54	...	11	Swift, streaks. Perseids.
298	1878	31	43	+58	July 27, 28, 29	8	Swift, streaks.
299	1887	31	46	+26	July 22, 27, 29	8	Swift, streaks.
300	1878	31	49	+31	July 30, Aug. 2	5	Slowish.
301	1878	31	70	+50	July 30	5	Not swift, streaks.
302	1878	31	96	+72	July 30	5	Slow.
303	1878	31	331	+62	Aug. 1, 2	5	Slow, faint, =347.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
304	1889	July 31	336°	−13°	July 27, 29, Aug. 3	6	Slow, long. Aquarids, =272-3-4-5.
305	1877	Aug. 1	23	+41	July 27, 31	7	Very swift, streaks.
306	1887	1	36	+56	...	4	Swift, streaks. Perseids.
307	1878	1	65	+60	July 30	7	Slow.
308	1877	1	291	+70	July 30, 31, Aug. 2	14	Swift, short.
309	1878	1	321	+31	July 31	10	Slow, bright.
310	1878	1	332	+50	July 26–31	14	Very swift, short, =243.
311	1886	2	33	+55	...	12	Swift, streaks. Perseids.
312	1888	2	35	+54	...	14	Swift, streaks. Perseids.
313	1881	2	39	+55	...	14	Swift, streaks. Perseids.
314	1886	2	291	+51	July 27, 28, Aug. 6, 10, 11	14	Swift, =330.
315	1878	2	333	+9	July 26–31	10	Very slow, =348.
316	1888	2	336	−11	Aug. 5	3	Slow, bright. Aquarids.
317	1877	3	40	+56	...	20	Swift, streaks. Perseids.
318	1886	4	7	+11	Aug. 2, 10	5	Swift.
319	1877	4	9	+34	Aug. 3	5	Swift, streaks, =336.
320	1886	4	20	+58	Aug. 2	6	Swift, streaks, =337.
321	1886	4	26	+42	Aug. 10	6	Swift, streaks.
322	1877	4	30	+36	Aug. 10	13	Swift, =279.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
323	1886	Aug. 4	32	+17	Aug. 2	5	Swift, =289, 323.
324	1886	4	37	+57	...	12	Swift, streaks.
325	1886	4	48	+43	Aug. 2, 10	10	Swift, streaks, =343.
326	1877	4	284	−12	Aug. 3, 5	4	Slow.
327	1877	4	340	−13	Aug. 3	4	Slow, bright. Aquarids, =304.
328	1886	4	350	+51	July 31, Aug. 2, 10, 11	11	Swift, =383.
329	1888	5	42	+57	...	11	Swift, streaks. Perseids.
330	1885	5	292	+52	Aug. 4	4	Slow, =314.
331	1887	6	31	+49	...	5	Swift, streaks, =376.
332	1887	6	42	+55	...	5	Swift, streaks. Perseids.
333	1886	6	334	+56	Aug. 4	4	Swift.
334	1878	7	3	+27	...	7	Not swift, bright.
335	1877	7	4	+20	Aug. 3	7	Swift.
336	1877	7	8	+38	...	5	Swift, =319, 356.
337	1877	7	18	+63	Aug. 12	15	Very swift, streaks, =320.
338	1877	7	40	+28	Aug. 3, 10, 12	8	Very swift, streaks.
339	1877	7	40	+56	...	20	Swift, streaks. Perseids.
340	1889	7	41	+58	...	10	Swift, streaks. Perseids.
341	1880	7	41	+55	...	14	Very swift, streaks. Perseids.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
342	1887	Aug. 7	43	+56	...	5	Swift, streaks. Perseids.
343	1877	7	46	+45	Aug. 10	6	Swift, streaks, =325.
344	1889	7	69	+51	Aug. 6, 10	6	Swift, streaks.
345	1880	7	300	−10	Aug. 6, 9	5	Very slow, =268.
346	1877	7	315	+51	Aug. 4, 10, 12	13	Swift.
347	1889	7	329	+62	July 29, 31, Aug. 3	13	Swift.
348	1877	7	330	+10	...	12	Slow, =315.
349	1877	7	335	+45	Aug. 10, 12	18	Swift.
350	1877	7	343	+12	Aug. 4, 10, 12	8	Swift.
351	1880	8	41	+55	...	23	Very swift, streaks. Perseids.
352	1888	8	42	+57	...	20	Swift, streaks. Perseids.
353	1887	8	43	+56	...	5	Swift, streaks. Perseids.
354	1880	9	44	+55	...	71	Very swift, streaks. Perseids.
355	1879	9	46	+58	Aug. 11, 12	38	Very swift, streaks. Perseids.
356	1878	10	6	+37	...	6	Swift, streaks, =336, 369.
357	1877	10	8	+53	Aug. 12	9	Swift.
358	1887	10	42½	+57½	...	22	Swift, streaks. Perseids.
359	1878	10	42½ 44	+54 +59	...	106	Swift, streaks. Perseids.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
360	1876	Aug. 10	43	+59	Aug. 5, 8, 11	43	Very swift, streaks. Perseids.
361	1877	10	43	+58	...	285	Very swift, streaks. Perseids.
362	1882	10	43	+57	...	8	Very swift, streaks. Perseids.
363	1874	10	44	+58½	...	252	Very swift, streaks. Perseids.
364	1884	10	44	+59	...	16	Very swift, streaks. Perseids.
365	1886	10	44	+57	...	122	Swift, streaks. Perseids.
366	1880	10	45	+57	...	41	Very swift, streaks. Perseids.
367	1877	10	70	+65	Aug. 12	10	Very swift.
368	1877	10	342	−12	Aug. 12	6	Slow, bright, long. Aquarids.
369	1876	11	8	+38	...	4	Swift, =356, 375.
370	1887	11	45	+57½	...	16	Swift, streaks. Perseids.
371	1882	11	46	+57	...	45	Very swift, streaks. Perseids.
372	1886	11	47	+57	...	15	Swift, streaks. Perseids.
373	1880	11	48	+57	...	43	Very swift, streaks. Perseids.
374	1885	11	296	± 0	Aug. 5, 8, 13	4	Rather slow.
375	1877	12	10	+38	...	6	Swift, =369.
376	1880	12	30	+46	Aug. 11, 13	5	Very swift, bright, streaks, =331.
377	1877	12	31	+18	...	11	Swift, streaks, =323.
378	1880	12	48	+57	...	19	Very swift, streaks. Perseids.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
379	1877	Aug. 12	50°	+55°	...	14	Very swift, streaks. Perseids.
380	1877	12	60	+48	Aug. 10, 16	8	Swift, streaks, =403.
381	1879	12	215	+76	Aug. 9, 11	5	Slow, bright.
382	1877	12	330	+70	...	13	Swift, short, =437.
383	1877	12	349	+53	Aug. 3, 7, 13	4	Swift, =328, 410.
384	1888	13	8	+33	Aug. 8, 14	5	Swift, streaks, =375.
385	1888	13	23	+36	Aug. 8	5	Swift, streaks.
386	1880	13	49½	+57½	...	7	Very swift, streaks, Perseids.
387	1888	13	52	+57	...	13	Swift, streaks. Perseids.
388	1885	13	51	+58	...	6	Very swift, streaks. Perseids.
389	1888	13	104	+79	Aug. 5, 8	5	Very swift, very short.
390	1888	13	312	+15	Aug. 2	5	Very slow, brilliant.
391	1885	13	329	+ 8	Aug. 15	7	Slow, brilliant.
392	1888	14	0	+53	Aug. 8, 13	6	Swift.
393	1887	14	23	+30	Aug. 21, 24	7	Swift.
394	1888	14	48	+44	Aug. 8, 9, 13	5	Swift, bright, streaks, =413.
395	1887	14	53	+57	...	8	Swift, streaks. Perseids.
396	1888	14	302	+24	Aug. 8, 13	4	Not swift, bright, =397.
397	1887	14	302	+23	Aug. 18, 21, 22	6	Rather slow, =396.

	Year.	Date.	Radiant. ■	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
398	1887	Aug. 14	320	+ 11	Aug. 22, 24	5	Slow.
399	1887	14	335	− 10	Aug. 11	5	Very slow. Aquarids.
400	1877	16	10	+ 37	...	4	Swift, =384.
401	1877	16	22	+ 46	Aug. 12	7	Swift.
402	1877	16	60	+ 59	...	5	Swift, streaks. Perseids.
403	1877	16	61	+ 48	...	4	Swift, streaks, =380, 432.
404	1877	16	292	+ 48	Aug. 10, 12	7	Swift, =407.
405	1885	16	318	− 9	Aug. 17	5	Slow.
406	1885	16	328	+ 27	Aug. 15, 17	5	Slow.
407	1885	17	292	+ 52	Aug. 15	5	Slow, =404.
408	1885	17	317	+ 22	Aug. 15, 20	5	Slow, faint.
409	1885	17	345	± 0	Aug. 16, 18, 20	7	Swift, =440.
410	1885	17	345	+ 53	Aug. 16, 18, 20	10	Swift, =383.
411	1884	19	25	+ 42	Aug. 21	5	Swift, streaks, =441.
412	1885	20	5	+ 12	Aug. 17	7	Slowish.
413	1884	20	46	+ 44	Aug. 19, 21	4	Swift, streaks, =394.
414	1887	20	242	+ 49	Aug. 22, 25	7	Very slow.
415	1887	20	297	+ 55	Aug. 14, 21	6	Slow.
416	1884	20	313	+ 10	Aug. 19	8	Very slow, yellow, trains.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
417	1884	Aug. 20	331°	+37°	Aug. 23	8	Short, swift, faint.
418	1885	20	351	+38	Aug. 16	5	Swift.
419	1884	21	5	+35	Aug. 20, 22	5	Swift.
420	1887	21	5	+54	Aug. 14	8	Swift, streaks.
421	1887	21	39	+28	Aug. 18	6	Swift, streaks. T. 48.
422	1879	21	40	+59	Aug, 20	7	Swift, streaks.
423	1887	21	54	+71	Aug. 14, 20	10	Very swift, streaks.
424	1887	21	73	+41	Aug. 7, 20, 22	10	Very swift, streaks. T. 66.
425	1879	21	253	+64	Aug. 22	7	Slow, trained, =449.
426	1884	21	263	+69	Aug. 23	7	Rather slow.
427	1887	21	296	+86	Aug. 22	4	Slowish. T. 52.
428	1879	21	332	+59	Aug. 22	5	Slow, =472.
429	1879	21	339	−10	Aug. 22, 23	16	Slow, bright. Aquarids.
430	1887	21	347	+15	Aug. 20, 23, 24	7	Slowish, =453.
431	1879	22	5	+17	Aug. 21, 23	8	Slow (5° too far N.)?. =456.
432	1879	22	61	+50	Aug. 21, 23	11	Swift, streaks, =403, 459.
433	1879	22	70	+66	Aug. 21, 23	9	Swift, streaks, =477.
434	1879	22	266	+47	...	7	Slow.
435	1879	21, 22, 23	291	+60	Aug. 25	56	Slow, bright, trains, =461.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
436	1879	Aug. 22	315	+47	Aug. 21	6	Slow, white.
437	1879	22	330	+69	Aug. 21	7	Slow, bright, trains, =382, 439.
438	1884	22	331	+ 7	Aug. 19, 20, 23	10	Slow, bright, trains.
439	1886	22	331	+71	Aug. 24	8	Swift, =437, 452.
440	1879	22	350	± 0	Aug. 21, 23	10	Slow, =409, 463.
441	1879	23	24	+42	Aug. 21, 22, 25	9	Very swift, streaks, =411.
442	1887	23	26	+72	Aug. 21, 24, 30	5	Swift, short, =466.
443	1887	23	32	+50	Aug. 14, 20, 21	5	Swift.
444	1887	23	43	+39	Aug. 24, 25	9	Swift, streaks.
445	1879	23	46	+47	Aug. 21, 22	9	Very swift, streaks, =480.
446	1884	23	60	+28	Aug. 21	4	Swift, streaks.
447	1879	23	62	+35	Aug. 21, 22, 25	10	Very swift, bright, streaks, =468.
448	1884	23	70	+50	Aug. 21, 22, 25, 26	11	Swift, streaks.
449	1887	23	264	+62	Aug. 14, 20, 22	7	Slow, bright, trains, =425.
450	1879	23	319	+30	Aug. 21, 22	12	Slow.
451	1887	23	327	+48	Aug. 21	8	Slow. T. 54.
M 452	1884	23	330	+68	Aug. 19, 20, 21, 25	10	Slow, =439, 475.
M 453	1879	23	343	+14	...	6	Swift, bright, =430.
454	1879	23	350	+47	...	8	Rather slow, =464.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance &c.
			°	°			
455	1884	Aug. 23	352	+13	Aug. 21, 25	5	Short, swift, faint.
456	1887	24	5	+12	Aug. 21, 22	4	Swift, =412, 431, 465.
457	1887	24	8	+45	Aug. 21, 22	5	Swift, short, streaks.
458	1884–6	24	16	+31	Aug. 19, 20, 21	5	Swift, streaks.
459	1887	24	60	+50	Aug. 21	5	Very swift, streaks, =432.
460	1887	24	135	+78	Aug. 20, 21, 22	7	Swift.
461	1887	24	289	+60	Aug. 21	5	Very slow, =435. T. 58.
462	1886	24	315	+42	Aug. 27, 28, 29	7	Swift.
463	1886	24	346	+ 1	Aug. 29	5	Swift, =440.
464	1887	24	349	+49	Aug. 21, 22, 25	11	Rather slow, =454.
465	1884	25	5	+10	Aug. 23	7	Slow, bright, short, =456.
466	1884	25	26	+70	...	5	Rather swift, =442.
467	1884	25	30	+36½	...	7	Swift, streaks.
468	1884	25	62	+37	...	4	Swift, streaks, =447.
469	1884	25	74	+15	...	...	Swift, streaks.
470	1887	25	301	+41	Aug. 22, 24	5	Slow.
471	1887	25	311	+65	Aug. 23	4	Very swift, =481.
472	1887	25	334	+58	Aug. 6, 20, 21, 24	10	Rather swift, =428.
473	1881	27	75	+33	...	5	Swift, streaks.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
474	1881	Aug. 27	330	+36	Aug. 25, 26	6	Slowish.
475	1881	27	330	+69	...	4	Slow, =452, 518.
476	1884-6	28	1	+63	Aug. 20, 25, 27	7	Slow, short.
477	1886	29	70	+65	Aug. 27, 28	5	Swift, streaks, =433.
478	1886	29	106	+52	...	6	Not swift.
479	1886	29	292	+70	Aug. 28	11	Swift, streaks.
480	1887	30	46	+43	Aug. 14, 24	4	Swift, streaks, =445.
481	1888	30	313	+65	Aug. 29, Sept. 7	6	Rather swift, short, =471.
482	1877	31	160	+78	Sept. 4, 5	6	Swift.
483	1885	Sept. 3	62	+37	...	7	Swift, streaks, =495.
484	1885	3	243	+48	Sept. 4	5	Very slow, yellow.
485	1885	3	253	+54	Sept. 4, 5	7	Very slow, yellow.
486	1885	3	311	+50	Sept. 4	4	Swift.
487	1885	3	354	+38	Sept. 1, 4, 5, 7	19	Very swift.
488	1877	4	28	+45	Sept. 15, 16	4	Rather swift.
489	1877	4	40	+72	Sept. 15, 16	6	Swift.
490	1877	4	286	+27	Sept. 1	4	Slow, faint.
491	1885	4	346	± 0	Sept. 1, 3, 8, 9	12	Slow, bright.
492	1885	5	4	− 2	Sept. 3	5	Rather swift, =522.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
493	1877	Sept. 5	16	+54	Sept. 4	8	Swift, =521.
494	1877	5	53	+64	Sept. 7	6	Swift, streaks.
495	1877–85	5	60	+35	Sept. 4	5	Swift, streaks, =483, 500.
496	1885–8	5	61	+49	Sept. 6, 8, 9	7	Swift, =504.
497	1877	5	70	+85	Sept. 4	7	Swift.
498	1877	5	85	+53	Sept. 4	8	Swift.
499	1888	6	48	+63	Sept. 7	5	Swift, streaks.
500	1880	6	61	+36	Sept. 2	4	Swift, streaks, =495, 503.
501	1877	6	220	+78	Sept. 4, 7	10	Swift.
502	1888	6	354	+67	Aug. 29, Sept. 9, 10	6	Rather swift.
503	1877	7	60	+38	...	5	Swift, streaks, =500, 505.
504	1877	7	61	+48	Sept. 4, 5	5	Swift, =496.
505	1886	7	62	+36	Aug. 28	6	Swift, streaks, =503, 511.
506	1877	7	73	+14	...	7	Swift, streaks, =516.
507	1877	7	100	+58	Sept. 5	10	Swift.
508	1877	7	260	+63	Sept. 5, 15	8	Swift.
509	1877	7	267	+20	Sept. 4	4	Slow.
510	1888	7	314	+26	Aug. 29	5	Slow.
511	1885	8	62	+37	Sept. 9, 10	4	Swift, streaks, =505.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
512	1885	Sept. 8	332 335	+32 +28	Sept. 9, 10, 11	10	Slow, faint.
513	1887	8	358	+60	Sept. 7, 12, 15	10	Slowish.
514	1888	9	33	+54	Sept. 6, 7	5	Swift, streaks.
515	1888	9	46	+23	Sept. 7	4	Very swift, streaks.
516	1885	9	72	+14	Sept. 19	5	Swift, streaks, =506.
517	1885	9	87	+20	Sept. 19	4	Very swift, streaks, =538.
518	1885	9	335	+71	Sept. 4, 5	7	Slow, bright, =475.
519	1877	12	10	± 0	Sept. 10	5	Swift.
520	1885	12	73	+43	Sept. 15	4	Swift, short, =549.
521	1887	13	20	+56	Sept. 22	5	Slowish, =493.
522	1879	14	1	− 5	Sept. 15	7	Very slow, =492.
523	1879	14	50	+54	...	7	Swift.
524	1879	14	54	+10	...	6	Swift, streaks.
525	1879	14	60	+29	Sept. 8	5	Swift, streaks.
526	1879	14	70	+ 4	Sept. 25	5	Swift, streaks.
527	1879	14	76	+33	Sept. 20, 21	10	Swift.
528	1879	14	82	+75	Sept. 18, 25	8	Not very swift, streaks.
529	1885	15	5	+11½	Sept. 12	8	Slow, =561.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
530	1885	Sept. 15	13°	+6°	Sept. 13, 17	7	Swift.
531	1885	15	25	+71	Sept. 12, 17	4	Swift, =557.
532	1879	15	30	+36	Sept. 14	8	Slowish, =567.
533	1885	15	48	+43½	Sept. 9	6	Very swift, =545.
534	1877	15	49	+14	Sept. 7, 16	6	Swift, streaks.
535	1877	15	61	+48	Sept. 15	5	Swift, =569.
536	1877	15	72	+14	Sept. 16	7	Swift, streaks.
537	1885	15	77	+57	Sept. 17	7	Very swift, streaks, =570.
538	1877	15	88	+17	Sept. 16	8	Swift, streaks, =517.
539	1877	15	101	+11	Sept. 16	5	Swift, streaks, =590.
540	1877	15	113	+24	Sept. 16	4	Not swift, long, =592.
541	1877	15	130	+46	...	5	Swift, streaks.
542	1877	15	156	+41	Sept. 5, 16	5	Swift, streaks.
543	1879	15	355	+18	...	8	Slow, bright, =582.
544	1877	16	20	+8	...	8	Very slow, =562.
545	1877	16	47	+45	Sept. 15	7	Swift, =533.
546	1877	16	50	+31	Sept. 18, 19	7	Slow.
547	1877	16	59	+9	Sept. 15	5	Swift, streaks.
548	1877	16	61	+36	Sept. 15	16	Swift, streaks, =553.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
549	1879	Sept. 16	72	+41	Sept. 15	6	Swift, streaks, =520, 571.
550	1877	16	87	+34	Sept. 13, 15, 18	13	Swift, =600.
551	1887	17	13	+38	Sept. 10, 15	5	Swift.
552	1887	17	55	+71	Sept. 15, 18, 24	5	Swift, streaks.
553	1885	17	62	+37	...	4	Swift, streaks, =548.
554	1887	17	64	+22	Sept. 18, 22, 24	8	Swift, streaks, =577.
555	1887	17	69	+70	Sept. 17, 19	6	Swift, streaks.
556	1885	17	345	± 0	...	4	Slow, bright, long.
557	1887	18	28	+72	Sept. 12, 22	7	Slowish, short, =531.
558	1887	18	41	+38	Sept. 17, 19	7	Swift, streaks, =565.
559	1887	18	87	+56	Sept. 17, 19	6	Swift, streaks, ? =537.
560	1887	18	110	+82	Sept. 12, 24	5	Slowish.
561	1887	19	5	+10	Sept. 13, 17, 18, 22	15	Slow, short, =529, 574.
562	1885	19	20	+14	...	4	Slow, =544.
563	1887	19	75	+15	Sept. 13, 18, 22	6	Swift, streaks, =599.
564	1876	20	14	+50	Sept. 18, 21	8	Rather slow.
565	1876	20	40	+40	...	5	Very swift, streaks, =558.
566	1879	20	192	+79	Sept. 18, 21, 25	9	Very, very slow.
567	1879	21	30	+36	Sept. 25	8	Slowish, long, =532.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
568	1879	Sept. 21	31	+19	Sept. 25	10	Slow, small, trains, =586.
569	1879	21	61	+48	Sept. 14	8	Swift, =535, 576.
570	1879	21	76	+56	Sept. 25	7	Not very swift, streaks, =537.
571	1879	21	76	+44	...	8	Swift, streaks, =549, 578.
572	1879	21	80	+25	Sept. 20, 25	4	Swift, streaks.
573	1879	21	87	+43	...	8	Very swift, streaks, =588.
574	1884	22	7	+10	...	5	Slow, short, =561.
575	1887	22	43	+7	Sept. 18, 26	5	Swift, streaks.
576	1884	22	59	+49	Sept. 21	5	Very swift, =569.
577	1886	22	63	+23	Sept. 21	7	Swift, streaks, =554.
578	1884	22	73	+45	...	8	Swift, streaks, =571, 606.
579	1886	22	85	+72	Sept. 18, 20	7	Swift.
580	1886	22	292	+71	Sept. 30	10	Slowish, streaks.
581	1887	22	335	+58	Sept. 17, 18, 19, 20	5	Slow.
582	1886	22	353	+18	Sept. 27	5	Slow, =543.
583	1886	22	357	+25	Sept. 18	5	Rather swift.
584	1887	24	7	+44	Sept. 13, 15, 22	7	Slowish.
585	1884	24	16	+33	Sept. 22, 27	4	Slow, bright.
586	1887	24	34	+19	Sept. 20	5	Rather swift, =568, 604.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
587	1879	Sept. 25	31	+52	Sept. 21	5	Slow, faint, =633.
588	1878	25	87	+42	Sept. 26	5	Very swift, streaks, =573.
589	1879	25	99	+43	Sept. 21	15	Very swift, streaks, =608.
590	1879	25	103	+11	Sept. 21	5	Very swift, long paths, =539.
591	1878	25	105	+73	Sept. 26	5	Not swift, =609.
592	1879	25	108	+24	Sept. 21	5	Very swift, streaks, long, =540.
593	1879	25	119	+15	...	3	Swift, streaks.
594	1878	25	127	+58	...	4	Swift, streaks.
595	1887	26	108	+43	Sept. 24	5	Very swift, streaks.
596	1884	26	271	+22	Sept. 27	...	Very slow, bright, trains.
597	1886	27	14	+12	Sept. 22, 30	8	Slowish, bright.
598	1886	27	48	+44	Sept. 22	6	Swift, =545, 621.
599	1886	27	75	+15	Oct. 2	10	Swift, streaks, bright, =563, 637.
600	1886	27	87	+35	...	5	Swift, streaks, =550.
601	1886	27	115	+52	Sept. 22, Oct. 2	8	Swift, streaks.
602	1886	30	25	+71	Sept. 30, Oct. 2	5	Swift, =623.
603	1886	30	347	± 0	Sept. 20, 26, Oct. 4	5	Slow, bright.
604	1886	Oct. 2	32	+19	Sept. 27, 30	5	Slowish, =586, 628.
605	1877	2	50	+85	Oct. 1, 3	9	Swift.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
606	1886	Oct. 2	73	+41	Sept. 20, 27, 30	7	Swift, streaks, =578.
607	1886	2	98	+29	Sept. 27	5	Swift, streaks.
608	1886	2	98	+43	Sept. 27	6	Swift, streaks, =589.
609	1877	2	100	+73	Oct. 3	9	Very swift, =591.
610	1886	2	115	+80	...	6	Swift, streaks.
611	1877	2	225	+52	...	7	Slow, trained, very bright.
612	1886	2	339	+64	Sept. 27, Oct. 2	6	Swift.
613	1877	3	167	+75	...	5	Swift, streaks.
614	1877	4	108	+38	Oct. 5, 6, 8	16	Very swift, streaks, =648.
615	1877	4	133	+79	Oct. 3, 5, 7	22	Swift, streaks.
616	1877	4	186	+71	Oct. 3, 5	6	Slowish.
617	1877	4	253	+64	Oct. 2, 3, 5	4	Swift, =630.
618	1877	4	290	+70	Oct. 2, 3, 5	7	Rather slow.
619	1877	4	310	+77	Oct. 3, 5, 8	17	Slowish.
620	1885	5	7	+35	Oct. 1, 7	4	Very slow, =631.
621	1877	5	47	+45	Oct. 7, 8	5	Not very swift, =598.
622	1877	5	56	+52	Oct. 8	4	Rather slow.
623	1879–85	6	25	+71	Oct. 4, 7, 8	7	Slowish, =602, 644.
624	1885	6	54	+71	Oct. 5	4	Slow.

No	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	
625	1879	Oct. 6	315°	+58°	Oct. 4, 11	11	Rather swift, =694.
626	1885	7	23	+17	Oct. 5	5	Rather slow.
627	1885	7	31	+ 8	...	5	Slow, =653.
628	1885	7	31	+18	Oct. 8	10	Slow, bright, =604.
629	1877	7	47	+16	Oct. 8	5	Swift.
630	1885	7	262	+64	Oct. 5, 12	5	Very slow, =617.
631	1877	8	8	+35	Oct. 14	7	Swift, =620.
632	1877	8	30	+36	Oct. 5, 7	10	Swift, short, =670.
633	1877	8	32	+50	...	8	Slow, =587.
634	1885	8	42	+55	Oct. 6, 12, 16	13	Slow, faint, =656.
635	1877	8	47	+28	...	8	Short, swift, 655.
636	1877	8	61	+47	Oct. 16, 17	8	Very swift, bright.
637	1877	8	74	+14	Oct. 16	4	Swift, faint, =599.
638	1877	8	77	+31	Oct. 5, 16	9	Swift, streaks, =658.
639	1877	8	80	+21	...	9	Very swift.
640	1877	8	84	+55	Oct. 5	18	Swift.
641	1877	8	103	+12	Oct. 15, 19	22	Very swift, streaks.
642	1877	8	133	+68	Oct. 5, 15	10	Swift, =664.
643	1887	11	13	+ 6	...	5	Slow, bright.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
644	1887	Oct. 11	29°	+72°	Oct. 12, 14, 15, 21	13	Small, short, =623, 650.
645	1887	12	42	+38½	Oct. 14, 15	6	Swift, short.
646	1887	12	87	+42	Oct. 11, 14, 15	9	Swift, streaks. T. 92.
647	1887	12	91	+17	Oct. 11, 13, 14	5	Swift, streaks. Orionids.
648	1885	12	103	+33	Oct. 6, 8	8	Swift, streaks, =614.
649	1876	13	14	+50	Oct. 14, 15	7	Slowish, faint.
650	1876	13	32	+70	Oct. 14, 15	5	Slow, faint, =644.
651	1887	13	192	+83	Oct. 11, 14	10	Slow, bright.
652	1877	14	21	+55	...	5	Slowish.
653	1879	14	31	+ 9	Oct. 15	31	Slow, trained, faint, =627.
654	1887	14	40	+20	Oct. 12, 13, 15–24	45	Rather swift.
655	1887	14	40	+29	Oct. 11, 13, 15	11	Swift, short, =635, 671.
656	1877	14	43	+58	Oct. 8	6	Swift, faint, =634, 657.
657	1879	14	48	+60	...	6	Very swift, streaks, =656.
658	1876	14	76	+33	Oct. 15	7	Swift, =638. T. 83.
659	1876	14	90	+58	Oct. 17, 25	6	Swift, streaks.
660	1879	14	95	+46	Oct. 15, 20	11	Very swift, streaks.
661	1887	14	105	+22	Oct. 15, 20, 21	12	Very swift, streaks, =677.
662	1879	14	114	+62	Oct. 15	7	Very swift, streaks.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
663	1887	Oct. 14	117	+47	Oct. 15, 17, 20	8	Swift, streaks.
664	1887	14	135	+68	Oct. 15, 17, 20, 23	11	Swift, =642.
665	1879	14	152	+38	Oct. 15	7	Swift, streaks, bright, =693.
666	1879	15	7	+51	Oct. 19, 20	11	Slow, faint.
667	1876	15	21	+14	Oct. 13, 14, 19	8	Very slow, bright, =626.
668	1879	15	24	+36	...	4	Slow.
669	1887	15	25	+44	Oct. 14	10	Small, slow, short.
670	1876	15	31	+37	Oct. 13, 14, 19	5	Swift, =632.
671	1876	15	46	+26	Oct. 14, 17	19	Swift, =655.
672	1879	15	70	+65	Oct. 14, 20	6	Swift, ?=673.
673	1887	15	71	+61	Oct. 13, 21	5	Swift, ?=672.
674	1879	15	78	+57	Oct. 14	12	Swift, streaks.
675	1887	15	91	+16	...	17	Swift, streaks. Orionids.
676	1879	15	105	+50	Oct. 14, 16, 20	5	Very swift, streaks, =704.
677	1879	15	106	+23	Oct. 20	14	Very swift, streaks, =661.
678	1887	15	109	+77	Oct. 14, 20, 21	7	Swift, small, short.
679	1879	15	124	+54	Oct. 20	4	Swift, streaks, =688.
680	1877	15	133	+21	Oct. 16, 17, 18	18	Very, very swift. T. 88.
681	1879	15	133	+48	Oct. 14, 20	6	Swift, streaks, =689.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
682	1877	Oct. 15	178°	+34°	Oct. 16	4	Swift, short.
683	1877	15	213	+79	...	8	Not very swift, =725.
684	1887	15	354	+69	Oct. 11, 14	6	Slow.
685	1887	16	85	+10	Oct. 17	7	Swift.
686	1887	16	119	+31	Oct. 6, 15	13	Swift, streaks.
687	1877	16	120	+15	Oct. 17	9	Very swift.
688	1877	16	127	+58	Oct. 17, 18.	10	Swift, streaks, =679.
689	1877	16	130	+47	Oct. 15, 17, 18	11	Swift, streaks, =681.
690	1885	16	133	+38	Oct. 8, 12	5	Swift.
691	1877	16	140	+28	Oct. 15, 17, 18	9	Swift, streaks.
692	1885	16	143	+49	Oct. 6	6	Swift, streaks.
693	1877	16	153	+42	Oct. 15, 17	4	Swift, streaks, =665.
694	1879	16	316	+60	Oct. 20	6	Swift, short, =625.
695	1876	17	38	+12	Oct. 14, 15, 25	5	Very slow.
696	1877	17	63	+22	...	7	Slowish, =724.
697	1876	17	88	+17	Oct. 19	8	Swift, streaks. Orionids.
698	1887	17	90	+15	...	3	Swift, streaks. Orionids.
699	1884	17	92	+14	...	4	Swift, streaks. Orionids.
700	1877	17	100	+1	Oct. 16, 18	5	Swift. T. 87.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
701	1887	Oct. 17	312	+77	Oct. 12, 14, 15	8	Swift.
702	1874	18	34	+18	Oct. 17	5	Swift, bright.
703	1877	18	92	+15	Oct. 17	57	Swift, streaks. Orionids.
704	1877	18	105	+50	Oct. 15, 16, 17	15	Very swift, =676, 719.
705	1877	18	121	± 0	Oct. 16, 17	6	Swift.
706	1877	19	84	−11	Oct. 15, 16, 17	7	Swift, streaks.
707	1887	19	90½	+15½	...	10	Swift, streaks. Orionids.
708	1879	20	45	+ 6	...	8	Slow, =721. T. 81.
709	1879	20	45	+46	Oct. 15	6	Swift, =710.
710	1887	20	47	+44	Oct. 17, 19, 21, 23	9	Swift, =709.
711	1879	20	71	+51	...	7	Swift.
712	1887	20	90	+14½	...	22	Swift, streaks. Orionids.
713	1879	20	93	+17	Oct. 15	39	Swift, streaks. Orionids.
714	1879	20	106	+12	Oct. 14, 15	7	Very swift, streaks, long.
715	1876	21	11	+ 8	Oct. 19	9	Very slow.
716	1887	21	54	+71	Oct. 14, 15, 20, 23	12	Swift.
717	1887	21	75	+15	Oct. 19, 20	4	Swift.
718	1887	21	92	+14	...	23	Swift, streaks. Orionids.
719	1887	21	105	+52	Oct. 14, 15, 20	5	Swift, =704.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
720	1887	Oct. 21	125	+43	Oct. 20	7	Swift, streaks.
721	1886	22	43	+ 5	...	5	Slow, short, faint, =708.
722	1878	22	91	+15	...	11	Swift, streaks. Orionids.
723	1887	24	91	+16	...	9	Swift, streaks. Orionids.
724	1876	25	61	+18	Oct. 21, 29	6	Not swift, bright, =696.
725	1885	27	213	+75	Nov. 5, 15	7	Slow, =683.
726	1885	29	26	+72	Nov. 5, 7	5	Slow.
727	1876	29	109	+23	Oct. 25	11	Very, very swift, =752.
728	1876	29	125	+47	...	17	Swift, streaks.
729	1877	31	40	+77	...	9	Not swift, faint.
730	1877	31	43	+21	...	8	Slow, bright, =731.
731	1877	Nov. 1	43	+23	Nov. 4, 5, 7	23	Slow, bright, trains, =730.
732	1886	2	55	+ 9	Nov. 3	17	Rather slow, bright, trains. T. 91.
733	1886	2	60	+27	Nov. 1, 3	6	Slow.
734	1886	2	97	+42	Nov. 3	5	Very swift.
735	1886	3	32	+ 8	Nov. 2	5	Small, slow, trains.
736	1886	3	38	+20	Nov. 2	5	Slow, ?=730–1.
737	1886	3	48	+21	Nov. 2	4	Rather swift, bright, ?=730–1.
738	1877	3	60	+34	Nov. 4, 5	12	Swift, =760.
739	1886	3	133	+43	...	4	Very swift, bright, streaks.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
740	1877	Nov. 4	25	+46	Nov. 7	4	Slow.
741	1877	4	61	+49	Nov. 7, 9	8	Swift, =777.
742	1877	4	62	+ 9	...	6	Slowish, trains.
743	1877	4	97	+25	Nov. 7	8	Swift.
744	1877	5	19	+30	Nov. 10	7	Slow, white.
745	1877	5	45	+60	Nov. 7	6	Swift.
746	1872	6	64	+20	Nov. 9, 10	12	Slowish, ?=749, 759.
747	1876	7	17	+53	Nov. 8	7	Rather swift.
748	1877	7	30	+16	Nov. 4, 5	11	Swift.
749	1877	7	57	+18	Nov. 1, 4	9	Slowish, =753.
750	1877	7	77	+32	Nov. 9	8	Not very swift, =761.
751	1877	7	102	+73	Nov. 4, 9, 10	13	Very, very swift.
752	1877	7	110	+25	Nov. 10, 12	8	Swift, =727.
753	1876	8	58	+16	Nov. 7	3	Not swift, bright, =749.
754	1877	9	29	+37	Nov. 4, 7, 10	5	Slowish.
755	1877	9	40	+10	Nov. 4	5	Slowish.
756	1877	10	133	+31	Nov. 12	10	Swift, streaks, =803.
757	1877	10	338	+59	...	6	Swift.
758	1879	12	5	+52	Nov. 10, 13	5	Rather swift, faint.
759	1879	12	62	+21½	...	14	Slow, =746, 768.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
760	1879	Nov. 12	62°	+34°	Nov. 13, 14	4	Slowish, =738.
761	1879	12	76½	+33	Nov. 13	5	Slow, =750, 794.
762	1877	12	107	+11	Nov. 10, 11	11	Very swift.
763	1877	12	125	+40	...	5	Swift, streaks, =786.
764	1877	12	127	+17	Nov. 10	12	Swift, long.
765	1879	12	143	+69	Nov. 13	8	Swift.
766	1879	13	46	+21	Nov. 12, 14	19	Slow, trained.
767	1879	13	48	+43	Nov. 12, 14	4	Slow, ?=820.
768	1879	13	58	+21	Nov. 14	11	Slow, =759.
769	1877	13	70	+65	...	6	Not swift, =799.
770	1877	13	103	+48	Nov. 10, 12	21	Swift.
771	1879	13	124	+55	...	5	Swift, streaks.
772	1879	13	133	+70	Nov. 12	8	Swift.
773	1879	13	148	+23	Nov. 12	18	Very swift, streaks. Leonids.
774	1877	13	148	+24	Nov. 10	5	Very swift, streaks. Leonids.
775	1888	13	149	+22	...	17	Swift, bright, streaks. Leonids.
776	1879	13	191	+58	...	5	Slow, bright, white.
777	1879	14	61	+48	Nov. 13	4	Slowish, =741.
778	1887	14	65	+24	Nov. 15, 23	4	Slowish, =768, 798.
779	1879	14	80	+24	Nov. 12, 13	7	Not swift, =810.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
780	1885	Nov. 14	143°	+50°	Nov. 15, 16	6	Very swift, streaks.
781	1885	14	149	+21	...	5	Very swift, streaks. Leonids.
782	1887	14	150	+22	...	7	Swift, streaks. Leonids.
783	1887	14	194	+67	Nov. 23	7	Swift, streaks.
784	1885	15	60	+28	Nov. 14, 17	6	Slow, bright, trains.
785	1885	15	73	+42	Nov. 14	5	Swift.
786	1885	15	125	+41	Nov. 14, 16	6	Swift, streaks, =763.
787	1885	16	100	+41	Nov. 14, 15	5	Swift.
788	1885	16	150	+22	...	6	Very swift, streaks. Leonids.
789	1885	16	154	+40½	Nov. 14	12	Very swift, streaks, =815.
790	1885	16	157	+74	Nov. 14, 15	5	Slow, faint.
791	1885	16	190	+21	Nov. 17	3	Very, very swift, streaks.
792	1885	16	200	+58	Nov. 15	4	Slow, =808.
793	1886	17	53	+71	Nov. 16, 18	8	Rather swift.
794	1886	17	76	+33	...	5	Slowish, =761.
795	1885	17	79	+56	Nov. 15, 16	6	Swift.
796	1885	17	166	+31	Nov. 14, 15, 16	10	Very swift, streaks.
797	1876	19	111	+22	Nov. 20	5	Very swift.
798	1876	20	62	+22½	...	11	Slowish, bright, long, =778, 822.
799	1876	20	69	+66	Nov. 19	8	Rather slow, faint, =769.

No.	Year.	Date.	Radiant. α	δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
800	1876	Nov. 20	85°	+33°	...	7	Slow, orange, ? = 794.
801	1876	20	149	+22	Nov. 19	5	Swift, streaks. ? Leonids.
802	1876	22	78	+43	Nov. 20, 25, 28	9	Swift, white.
803	1887	23	132	+31	Nov. 14	5	Swift, streaks, = 756, 849.
804	1887	23	141	+27	Nov. 14	5	Swift, streaks.
805	1887	23	157	+49	Nov. 14	5	Swift, streaks.
806	1887	23	169	+74	Nov. 29, 1877	5	Slow.
807	1887	23	181	+25	...	3	Swift, streaks, = 825.
808	1887	23	200	+56	...	4	Slowish, = 792.
809	1877	25	24	+45	Nov. 27	9	Very slow, yellow, trains. Andromedes.
810	1876	25	79	+21	Nov. 22, 26	7	Not swift, = 779, 823.
811	1876	25	112	+13	Nov. 26–28	7	Very swift.
812	1876	25	140	+65	Nov. 26–28	16	Very swift.
813	1885	26	26	+44	...	60	Very slow, trains. Andromedes.
814	1876	26	148	+ 2	Nov. 25, 27, 28	11	Very, very swift, streaks, = 866.
815	1876	26	155	+36	Nov. 25, 27, 28	26	Very, very swift, streaks, = 789.
816	1876	26	208	+43	Nov. 25, 27, 28	17	Swift, short.
817	1885	26	332	+58	Nov. 27	5	Slowish, white.
818	1872	27	29	+46	...	79	Very slow, small. Andromedes.
819	1885	27	24	+44	...	...	Very slow, trains. Andromedes.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
820	1877–80	Nov. 27	48	+42	Dec. 2, 4, 8	10	Slow, ? = 767.
821	1877	27	54	+48	...	4	Swift, ? = 840.
822	1880	27	63	+21	Nov. 28	8	Slow, bright, trains, = 798, 832.
823	1880	27	78	+24	Nov. 28	5	Slowish, bright, = 810.
824	1876	27	170	+ 4	Nov. 20, 25, 26	6	Very, very swift.
825	1876	27	179	+29	Nov. 28, 29	8	Swift, short, = 807.
826	1885	28	22	+43½	...	55	Very slow, trains, faint. Andromedes.
827	1885	28	37	−13	Dec. 1	3	Very slow, bright.
828	1876	28	212	+18	Nov. 27	7	Slowish, faint.
829	1886	29	27	+71	Nov. 30	5	Slow, short, faint, = 838.
830	1886	29	44	+56	...	10	Slow, trains, = 847.
831	1877	29	60	+37	Nov. 27, 29, Dec. 1	5	Slow, white, = 841.
832	1886	29	64	+23	Nov. 30, Dec. 1	6	Rather slow, = 822.
833	1877	29	70	+15	Nov. 27	5	Not very swift.
834	1877	29	100	+72	Dec. 1–6	4	Swift.
835	1877	29	104	+48	Nov. 30, Dec. 8	7	Swift.
836	1877	29	185	+71	Dec. 1	9	Swift, streaks.
837	1885	30	21	+42½	...	10	Very slow, trains, faint. Andromedes.
838	1885	30	27	+71	Nov. 28, Dec. 1	6	Slow, = 829, 870.
839	1885	30	41	+39	Nov. 28	6	Swift.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
840	1885	Nov. 30	60°	+49°	Nov. 28, Dec. 1–10	8	Very swift, ? =821.
841	1886	30	61	+37	Nov. 29	5	Slow, =831.
842	1886	30	81	+22	Nov. 29	6	Slow, =852.
843	1886	30	109	+58	Nov. 29	5	Swift.
844	1886	30	136	+77	Dec. 2, 5	5	Swift.
845	1886	30	190	+58	Nov. 18, Dec. 5	6	Swift, streaks.
846	1886	30	190	+79	Nov. 29	6	Swift.
847	1885	Dec. 1	44	+56	Dec. 9, 10	10	Slow, faint, trains, =830.
848	1885	1	194	+43	Nov. 30, Dec. 4	8	Very swift, streaks.
849	1877	2	131	+32	Dec. 8	6	Swift, streaks, =803.
850	1886	2	162	+58	Nov. 30, Dec. 2, 4, 6	6	Very swift, streaks, =873.
851	1885	4	31	+37	Nov. 30, Dec. 7	5	Very slow, trains.
852	1885	4	79	+24	Dec. 7	8	Slow, =842.
853	1885	4	105	+34	Dec. 1	8	Swift. Geminids.
854	1885	4	110	+25	Dec. 7–10	11	Slowish.
855	1885	4	143	+48½	Dec. 7	11	Swift, streaks.
856	1876	6	70	+67	Dec. 4, 8	6	Slowish.
857	1876	6	80	+23	Dec. 4, 8	13	Slow, bright, =852, 858.
858	1877	6	80	+25	Nov. 29, Dec. 1–8	6	Slow, =857, 890.
859	1885	7	88	+19	Nov. 30, Dec. 4, 9, 10	11	Slowish.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
860	1836	Dec. 5	105	+11	Nov. 30, Dec. 2	5	Swift.
861	1885	7	115	+33	Dec. 8	11	Not swift, =877.
862	1885	7	142	+27	Dec. 4, 9, 10	5	Very swift, streaks.
863	1877	8	87	+37	...	5	Rather swift.
864	1876	8	103	+31	Dec. 6	20	Bright, slowish. Geminids.
865	1877	8	109	+33	Dec. 6, 10	9	Swift. Geminids.
866	1877	8	145	+ 7	Dec. 10	8	Swift, bright, streaks, =814.
867	1876	8	208	+71	Dec. 4, 6	11	Swift, white.
868	1884	8	214	+62	...	4	Slowish.
869	1884	8	230	+85	...	4	Short, swift, faint.
870	1885	9	28	+70	Dec. 10	7	Slow, bright, trains, =838.
871	1885	9	99	+70	Dec. 1, 10	5	Swift.
872	1885	9	158	+72	Dec. 1, 10	10	Rather swift.
873	1885	9	161	+58	Dec. 4, 7	6	Very swift, =850.
874	1885	9	203	+57	Dec. 7, 8	5	Swift, white.
875	1885	10	105	+50	Dec. 9	6	Not swift.
876	1885	10	107	+33	Dec. 9	28	Swift, short. Geminids.
877	1885	10	117	+32	Dec. 9	10	Slowish, bright, =861.
878	1885	10	143	+39	Dec. 9, 11	5	Swift, streaks.
879	1885	10	152	+40	Dec. 2, 5, 7	8	Swift, streaks.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
			°	°			
880	1876	Dec. 12	109	+33	Dec. 11, 13	24	Slowish, bright. Geminids.
881	1877	12	166	± 0	Dec. 10, 24, 29	7	Very swift, streaks.
882	1877	12	173	+11	...	5	Swift, streaks.
883	1876	12	187	+37	...	6	Not swift.
884	1876	12	221	+53	Dec. 21	8	Rather slow, trains.
885	1876	13	79	+49	Dec. 8, 12	12	Swift, white.
886	1877	13	199	+19	Dec. 12	5	Swift, short.
887	1877–86	13	220	+14	Nov. 28, Dec. 5	6	Not very swift.
888	1877	13	221	+43	Dec. 12	4	Swift, streaks.
889	1877	13	230	+33	Dec. 12	5	Swift, short.
890	1886	18	80	+24	Dec. 15, 22, 28	6	Slow, =858.
891	1886	18	134	+ 8	Dec. 20, 22	6	Very swift.
892	1875	19	277	+73	Dec. 23	4	Slowish.
893	1886	20	47	+65	Dec. 15, 22, 29	5	Slow, faint, trains.
894	1876	21	129	+19	...	5	Slowish, faint, =899.
895	1876	21	165	− 6	Dec. 12	5	Very swift, streaks.
896	1886	22	194	+67	Dec. 18, 20, 24, 29	17	Swift, streaks.
897	1886	22	201	+ 4	Dec. 21, 28	4	Very swift, streaks.
898	1886	24	77	+32	Dec. 22, 28, 29	5	Slow.
899	1886	24	129	+19	Dec. 22	5	Rather swift, =894.

No.	Year.	Date.	Radiant. α	Radiant. δ	Other Nights of Observation.	No. of Meteors.	Appearance, &c.
900	1886	Dec. 24	145°	+ 7°	Dec. 20, 28, 29	5	Swift, streaks, = 13.
901	1886	24	184	+ 39	Dec. 28	6	Very swift, streaks.
902	1886	24	207	+ 18	Dec. 22, 29	5	Very swift, streaks.
903	1886	24	218	+ 36	Dec. 22	8	Very swift, bright, streaks.
904	1886	24	248	+ 70	...	5	Swift, faint.
905	1886	25	98	+ 31	Dec. 20, 24, 28, 29	11	Very slow.
906	1886–8	28	47	+ 44	Jan. 2, 11	7	Very slow, trains.
907	1886	28	115	+ 32	Dec. 22, 24, 29	7	Slow.
908	1886	28	133	+ 43	Dec. 28, 29	5	Swift.
909	1886	28	177	+ 49	Dec. 29	5	Swift, streaks.
910	1886	28	194	+ 32	Dec. 18, 22, 29	7	Very swift, streaks.
911	1886	29	125	+ 39	Dec. 24, 28	5	Slow.
912	1886	29	168	+ 18	Dec. 21, 22	5	Swift, = 918.
913	1886	29	231	+ 52	Dec. 28	5	Rather swift, long, = 1.
914	1886	29	293	+ 70	Dec. 18, 22	5	Slow.
915	1877	31	92	+ 57	...	4	Slow, bright.
916	1872	31	106	+ 36	Jan. 4, 5, 7	10	Slow.
917	1872	31	140	+ 45	Jan. 8	5	Swift.
918	1872	31	164	+ 20	...	4	Swift, = 912.

List of 45 *Long-enduring and apparently Stationary Radiant Points of Shooting Stars.*

(*Arranged according to R.A.*)

Ref. No.	Apparent Duration of Radiant.	Place of Radiant. α	δ	Approximate Star.
1	July 11–September 22	6°	+11°	γ Pegasi.
2	July 11–October 8	7	+35	π Andromedæ.
3	August–November	27	+71	φ Custos Messium.
4	July 27–December 7	30	+36½	β Trianguli.
5	July 30–November 7	32½	+18	α Arietis.
6	July–January 11	47	+44	β Persei.
7	July–November	54	+71	H_5 Camelopardi.
8	August 2–December 8	61	+37	ε Persei.
9	July–December	61	+49	μ Persei.
10	September–December	64	+22	ε Tauri.
11	August–February	73	+41	α Aurigæ.
12	August 25–December	74	+14½	11 Orionis.
13	July 23–December 31	77	+32	β Tauri.
14	September–November	77	+56½	ξ Aurigæ.
15	September–December	98	+43	58 Aurigæ.
16	September–December	104	+11½	β Canis Minoris.
17	October 15–December	116	+31	α–β Geminorum.
18	September 25–January	120	+15	β Cancri.
19	October 14–December 31	130	+20	δ Cancri.
20	November–February 1	132	+31	ι Cancri.
21	October 17–December 29	134	+ 8	ζ Hydræ.
22	November–February	134	+68	σ Ursæ Majoris.
23	October 15–January 11	141	+28	κ Leonis.
24	October–April	142	+49	θ Ursæ Majoris.
25	November 26–February 27	145	+ 7	ο Leonis.
26	September–December	154	+40½	μ Ursæ Majoris.
27	Nov.–Dec. and Mar.–Apr.	161	+58	β Ursæ Majoris.
28	November 14–January 19	167	+ 4	τ Leonis.
29	November 7–April 13	175	+10	β Leonis.
30	Oct.–Nov. and April	190	+58	ε Ursæ Majoris.
31	Nov., Dec., and Jan.	221	+14	ζ Boötis.
32	January–May	227	− 3	β Libræ.
33	January–May	235	+10½	α Serpentis.
34	Jan.–May and Sept.	253	+55½	μ Draconis.
35	January–June	261	+ 4½	β Ophiuchi.
36	Whole year	262	+63	ζ Draconis.

Ref. No.	Apparent Duration of Radiant.	Place of Radiant. α δ	Approximate Star.
37	March–September	272 + 21½	102 Herculis.
38	February–August	281 − 13	λ Aquilæ.
39	April–August	296 ± 0	η Aquilæ.
40	April–September	302 + 23½	17 Vulpeculæ.
41	March–October	313 + 77	κ Cephei.
42	May 13–August 13	314 + 15	γ Delphini.
43	March–September	315 + 49	α Cygni.
44	July–Sept., Nov. and Jan.	334 + 58	δ Cephei.
45	June–December	346 ± 0	β Piscium.

Bristol: 1889 *October* 4.

Ephemeris for Physical Observations of the Moon. By A. Marth.

1890 July 1 to December 31.

Greenwich Noon.	Selenographical Colong. of the Sun.	Selenographical Lat. of the Sun.	Geocentric Libration. Sel. Long. of the Earth.	Geocentric Libration. Lat. of the Earth.	Geocentric Libration. Combined Amount.	Direction.
1890.	°	°	°	°	°	°
July 1	78·85	+0·44	−4·13	+0·07	4·13	89·1
2	91·04	·47	2·46	1·82	3·06	53·6
3	103·23	·50	−0·60	3·46	3·51	9·8
4	115·42	·53	+1·31	4·86	5·04	344·9
5	127·62	·55	3·13	5·92	6·70	332·2
6	139·82	+0·58	+4·72	+6·57	8·09	324·4
7	152·03	·61	5·98	6·80	9·04	318·9
8	164·24	·63	6·83	6·60	9·49	314·2
9	176·46	·66	7·27	6·02	9·43	309·8
10	188·68	·68	7·31	5·15	8·94	305·3
11	200·91	·70	7·00	4·03	8·07	300·1
12	213·15	·72	6·37	2·74	6·94	293·4
13	225·39	+0·74	+5·50	+1·35	5·67	283·8
14	237·64	·76	4·44	−0·08	4·45	269·0
15	249·89	·78	3·25	1·49	3·58	245·4
16	262·14	·80	1·96	2·82	3·44	214·9
17	274·39	·82	+0·63	4·02	4·07	188·9
18	286·64	·84	−0·72	5·04	5·09	171·9
19	298 89	·86	2·05	5·85	6·19	160·7
20	311·14	+0·88	−3·33	−6·40	7·22	152·6
21	323·38	·90	4·52	6·68	8·07	146·1
22	335·62	·92	5·58	6·67	8·69	140·3

Greenwich Noon.	Selenographical Colong. of the Sun.	Lat. of the Sun.	Geocentric Libration. Sel. Long. of the Earth.	Lat. of the Earth.	Combined Amount.	Direction.
1890.	°	°	°	°	°	°
July 23	347·85	+0·95	−6·45	−6·36	9·05	134·7
24	0·08	·97	7·09	5·74	9·10	129·2
25	12·30	0·99	7·43	4·82	8·85	123·1
26	24·51	1·01	7·41	3·62	8·24	116·1
27	36·72	+1·04	−6·98	−2·18	7·32	107·4
28	48·92	1·06	6·12	−0·56	6·14	95·3
29	61·11	1·08	4·81	+1·13	4·95	76·8
30	73·30	1·11	3·12	2·79	4·19	48·2
31	85·49	1·13	−1·15	4·29	4·44	14·9
Aug. 1	97·67	1·15	+0·97	5·48	5·57	350·1
2	109·86	1·17	3·04	6·29	6·98	334·3
3	122·05	+1·19	+4·88	+6·64	8·24	323·8
4	134·24	1·21	6·36	6·56	9·13	314·0
5	146·44	1·22	7·38	6·06	9·54	309·6
6	158·65	1·24	7·89	5·24	9·46	303·7
7	170·86	1·25	7·93	4·15	8·94	297·7
8	183·08	1·27	7·54	2·89	8·07	291·0
9	195·30	1·28	6·80	1·52	6·97	282·6
10	207·53	+1·29	+5·80	+0·13	5·80	271·3
11	219·76	1·30	4·60	−1·28	4·78	254·5
12	232·00	1·31	3·30	2·60	4·19	231·7
13	244·24	1·32	1·94	3·80	4·26	207·0
14	256·48	1·33	+0·57	4·83	4·86	186·8
15	268·73	1·34	−0·75	5·65	5·70	172·4
16	280·97	1·36	2·02	6·23	6·54	162·1
17	293·21	+1·37	−3·20	−6·54	7·27	154·0
18	305·45	1·38	4·27	6·56	7·82	147·0
19	317·69	1·39	5·22	6·28	8·16	140·4
20	329·92	1·40	6·02	5·70	8·28	133·6
21	342·15	1·41	6·62	4·85	8·20	126·4
22	354·37	1·43	6·99	3·74	7·92	118·3
23	6·58	1·44	7·05	2·40	7·45	108·9
24	18·79	+1·45	−6·77	−0·90	6·83	97·6
25	30·99	1·46	6·08	+0·70	6·12	83·4
26	43·18	1·47	4·99	2·31	5·49	65·1
27	55·36	1·48	3·48	3·80	5·15	42·4
28	67·54	1·49	−1·64	5·06	5·32	17·9

Greenwich Noon.	Selenographical Colong. of the Sun.	Selenographical Lat. of the Sun.	Geocentric Libration. Sel. Long. of the Earth.	Geocentric Libration. Lat. of the Earth.	Combined Amount.	Direction.
1890.	°	°	°	°	°	°
Aug. 29	79·72	+1·50	+0·40	+5·98	5·99	356·2
30	91·90	1·51	2·48	6·48	6·93	339·2
31	104·07	+1·52	+4·38	+6·52	7·85	326·2
Sept. 1	116·25	1·52	5·96	6·12	8·53	316·0
2	128·43	1·53	7·08	5·35	8·86	307·3
3	140·62	1·53	7·69	4·29	8·80	299·3
4	152·81	1·53	7·79	3·03	8·35	291·3
5	165·01	1·53	7·43	1·65	7·61	282·5
6	177·21	1·53	6·70	+0·23	6·70	272·0
7	189·42	+1·53	+5·67	−1·17	5·78	258·3
8	201·63	1·53	4·44	2·49	5·09	240·7
9	213·85	1·53	3·10	3·69	4·82	220·1
10	226·07	1·53	1·74	4·72	5·03	200·2
11	238·29	1·52	+0·40	5·55	5·56	184·1
12	250·52	1·52	−0·87	6·14	6·20	171·9
13	262·75	1·52	2·01	6·47	6·77	162·8
14	274·98	+1·52	−3·04	−6·51	7·18	155·1
15	287·21	1·52	3·93	6·25	7·38	147·9
16	299·44	1·52	4·68	5·69	7·36	140·7
17	311·67	1·52	5·28	4·87	7·18	132·8
18	323·89	1·52	5·71	3·76	6·83	123·4
19	336·10	1·52	5·97	2·45	6·45	112·4
20	348·31	1·51	5·97	−0·99	6·06	99·5
21	0·51	+1·51	−5·72	+0·55	5·83	84·5
22	12·71	1·51	5·16	2·10	5·57	67·8
23	24·90	1·51	4·26	3·56	5·55	50·0
24	37·06	1·51	3·02	4·83	5·69	32·0
25	49·25	1·50	−1·49	5·80	5·99	14·4
26	61·42	1·50	+0·24	6·39	6·40	357·8
27	73·58	1·49	2·04	6·55	6·86	342·8
28	85·74	+1·48	+3·73	+6·27	7·28	329·4
29	97·90	1·47	5·17	5·59	7·61	317·3
30	110·06	1·46	6·23	4·56	7·72	306·3
Oct. 1	122·22	1·45	6·84	3·30	7·59	295·8
2	134·39	1·44	6·97	1·89	7·22	285·2
3	146·56	1·42	6·67	+0·42	6·68	273·7
4	158·74	1·41	5·98	−1·02	6·06	260·3

Greenwich Noon.	Selenographical Colong. of the Sun.	Selenographical Lat. of the Sun.	Geocentric Libration. Sel. Long. of the Earth.	Geocentric Libration. Lat. of the Earth.	Geocentric Libration. Combined Amount.	Geocentric Libration. Direction.
1890.	°	°	°	°	°	°
Oct. 5	170·93	+1·39	+4·99	−2·39	5·53	244·4
6	183·12	1·38	3·80	3·62	5·25	226·3
7	195·31	1·36	2·49	4·68	5·31	208·0
8	207·51	1·35	+1·15	5·54	5·66	191·7
9	219·71	1·34	−0·14	6·16	6·17	178·8
10	231·92	1·32	1·32	6·52	6·65	168·6
11	244·13	1·31	2·36	6·59	7·00	160·4
12	256·35	+1·29	+3·22	−6·37	7·13	153·3
13	268·56	1·28	3·89	5·83	7·00	146·4
14	280·78	1·27	4·37	4·99	6·63	138·9
15	292·99	1·25	4·67	3·90	6·08	129·9
16	305·20	1·24	4·79	2·58	5·44	118·3
17	317·41	1·23	4·74	−1·10	4·87	103·0
18	329·61	1·21	4·51	+0·46	4·54	84·1
19	341·81	+1·20	−4·09	+2·02	4·56	63·6
20	354·00	1·19	3·47	3·49	4·92	44·8
21	6·18	1·17	2·64	4·77	5·45	28·9
22	18·35	1·15	1·59	5·77	5·99	15·4
23	30·52	1·13	−0·38	6·42	6·45	3·4
24	42·68	1·12	+0·94	6·67	6·74	352·0
25	54·83	1·10	2·29	6·50	6·89	340·7
26	66·98	+1·07	+3·55	+5·92	6·89	329·2
27	79·13	1·05	4·61	4·97	6·77	317·3
28	91·27	1·03	5·38	3·74	6·55	304·9
29	103·42	1·00	5·80	2·32	6·25	291·9
30	115·57	0·98	5·85	+0·81	5·90	277·9
31	127·72	·95	5·52	−0·70	5·56	262·8
Nov. 1	139·87	·93	4·84	2·14	5·30	246·1
2	152·03	+0·90	+3·90	−3·45	5·20	228·4
3	164·19	·87	2·76	4·59	5·35	210·9
4	176·36	·85	1·49	5·51	5·71	195·1
5	188·54	·82	+0·19	6·19	6·19	181·7
6	200·72	·80	−1·08	6·61	6·70	170·7
7	212·90	·77	22	6·74	7·10	161·9
8	225·09	·75	3·19	6·58	7·31	154·2
9	237·29	+0·73	−3·95	−6·11	7·26	147·2
10	249·49	·71	4·45	5·33	6·94	140·2
11	261·69	·68	4·69	4·26	6·33	132·4

Greenwich Noon. 1890.	Selenographical Colong. of the Sun.	Lat. of the Sun.	Geocentric Libration. Sel. Long. of the Earth.	Lat. of the Earth.	Combined Amount.	Direction.
	°	°	°	°	°	°
Nov. 12	273·89	+0·66	−4·67	−2·94	5·51	122·3
13	286·09	·64	4·40	−1·44	4·63	108·1
14	298·29	·62	3·93	+0·17	3·93	87·5
15	310·48	·60	3·27	1·80	3·73	61·2
16	322·67	+0·57	−2·47	+3·33	4·15	36·5
17	334·86	·55	1·55	4·68	4·92	18·2
18	347·04	·52	−0·56	5·74	5·77	5·5
19	359·21	·50	+0·48	6·46	6·48	355·8
20	11·37	·47	1·51	6·78	6·95	347·5
21	23·53	·44	2·51	6·69	7·14	339·6
22	35·68	·42	3·41	6·20	7·07	331·3
23	47·82	+0·39	+4·16	+5·35	6·78	322·3
24	59·96	·36	4·72	4·20	6·31	311·8
25	72·09	·32	5·05	2·83	5·78	299·3
26	84·22	·29	5·11	+1·33	5·28	284·6
27	96·36	·26	4·90	−0·21	4·91	267·5
28	108·49	·23	4·42	1·69	4·73	249·1
29	120·63	·20	3·68	3·10	4·81	229·8
30	132·77	+0·16	+2·72	−4·32	5·11	212·2
Dec. 1	144·91	·13	1·60	5·33	5·56	196·6
2	157·06	·10	+0·36	6·09	6·10	183·3
3	169·21	·07	−0·93	6·59	6·64	172·0
4	181·37	·04	2·19	6·81	7·15	162·3
5	193·54	+0·02	3·35	6·74	7·52	153·7
6	205·71	−0·01	4·34	6·36	7·70	145·8
7	217·88	−0·04	−5·09	−5·69	7·63	138·3
8	230·06	·07	5·55	4·72	7·28	130·5
9	242·25	·09	5·68	3·48	6·66	121·6
10	254·44	·12	5·45	2·02	5·82	110·4
11	266·63	·14	4·88	−0·41	4·89	94·8
12	278·82	·16	3·99	+1·27	4·18	72·4
13	291·01	·19	2·85	2·89	4·06	44·5
14	303·20	−0·21	−1·53	+4·35	4·62	19·8
15	315·39	·24	−0·14	5·53	5·53	1·4
16	327·57	·26	+1·23	6·35	6·47	349·0
17	339·74	·29	2·50	6·76	7·21	339·8
18	351·90	·32	3·59	6·75	7·65	332·1

Greenwich Noon.	Selenographical Colong. of the Sun.	Selenographical Lat. of the Sun.	Geocentric Libration. Sel. Long. of the Earth.	Geocentric Libration. Lat. of the Earth.	Geocentric Libration. Combined Amount.	Direction.
1890.	°	°	°	°	°	°
Dec. 19	4·06	−0·35	+4·45	+6·34	7·74	325·1
20	16·21	·38	5·07	5·57	7·52	317·8
21	28·36	−0·41	+5·43	+4·50	7·04	309·8
22	40·50	·44	5·54	3·20	6·39	300·1
23	52·63	·47	5·41	1·75	5·69	288·0
24	64·76	·50	5·07	+0·25	5·08	272·8
25	76·89	·53	4·53	−1·26	4·70	254·4
26	89·02	·56	3·80	2·67	4·64	234·8
27	101·15	·59	2·90	3·94	4·89	216·3
28	113·28	−0·62	+1·86	−5·01	5·35	200·3
29	125·41	·65	+0·70	5·85	5·89	186·8
30	137·54	·68	−0·55	6·42	6·45	175·2
31	149·68	−0·70	−1·83	−6·72	6·96	164·8

Errata in Vol. II. of Oppolzer's Lehrbuch zur Bahnbestimmung.
By Lieut.-General J. F. Tennant, R.E., F.R.S.

I have found the following errors in addition to the extended list issued subsequently to the publication of the work.

Page 11. Formula 16. For $C^{d-p}\{1, 2, 3 \ldots d-1\}$, read $C^{d-p}\{1^2, 2^2, 3^2 \ldots (d-1)^2\}$.

15. Line 7 from bottom. For $mf\{a+(i+\frac{1}{2})w\}$, read $mf'\{a+(i+\frac{1}{2})w\}$.

32. Line 8 from bottom, in dl after $l(a+[i+n]w)$, for + read =.

41. Formula 15. In the limits of integration, for $a+(i+\frac{1}{2}m)$, read $a+(i+\frac{1}{2})m$.

108. Line 2 from bottom. For $\frac{1}{24}f(a)+$, read $\frac{1}{24}f(a)-$.

148. Line 1. For $(\nu)^2$, read $((\nu))^2$.

150. Line 3 from bottom. For $\tau' t$, read τ'.

151. Line 7 from bottom. For $(12\gamma - a\alpha)$, read $(12\gamma + a\alpha)$.

163. Line in formula for β. For $\frac{\sin\frac{1}{2}(E-E_0)}{\frac{1}{2}(E-E_0)}$, read $\frac{\sin\frac{1}{2}(E-E_0)}{\frac{1}{2}(E-E_0)\sin 1''}$.

I may mention also that there seem to be errors in the figures of the computations from careless reading, thus :—

Page 110. Log. $S_{(x)}$	for Oct. 27	should be	$2_n{\cdot}861612$	instead of	$1_n{\cdot}861612$.
„ $S_{(z)}$	„ Dec. 6	„	$0_n{\cdot}075547$	„	$0_n{\cdot}045547$.
111. Log. fq	„ Feb. 24	„	2·328069	„	2·308069.
fqx	„ Dec. 6	„	$2_n{\cdot}028385$	„	2·128385.
fqz	„ Oct. 27	„	1·732151	„	1·733151.
$\Delta\Sigma(z)$	„ Oct. 27	„	−0·62	„	−0·00

Erratum.

Vol. L., page 353, line 12 from bottom, *for* "*Berliner*" *read* "*Nautisches.*"